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WOUNDS OF THE CHEST IN PACIFIC JUNGLE WARFARE

A REVIEW OF THIRTY-TWO CASES

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The character, clinical course and end results of penetrating war wounds of the chest are influenced by three general factors: (1) the size, irregularity, velocity and course of the penetrating missile; (2) the general physical condition of the soldier when wounded, and (3) the promptness of first aid and the early transportation of the wounded man to a hospital which has adequate facilities and personnel for the care of wounds of the chest.

A series of 32 patients with wounds of the chest are presented. They represent all of the patients seen in the hospital in which I have been serving during a relatively short intensive engagement. The men previously had all been in the same general physical condition, and they were all efficiently treated early by the same medical organization. Since these two general factors are similar, the cases of these patients wounded in Pacific jungle warfare are reviewed to illustrate the types of penetrating missiles, the damage resulting therefrom and the early results of treatment of the wounds.

The type of penetrating missile depends, of course, on the type of weapon utilized by the enemy. Obviously, wounds differ in land, sea and air combat, but even in the various types of engagements on land the weapons used and the wounds sustained differ greatly. In this war so many varieties of combat exist that the wounds sustained and the care required may differ considerably. The cases here presented will in no way be comparable to those seen after bombing raids, intensive artillery engagements or tank warfare on other fronts. The weapons utilized by the enemy in this engagement and therefore the wounds sustained are typical of Pacific jungle warfare.

Wounds caused by rifle and machine gun fire are essentially similar, and because it is often difficult to determine accurately the weapon used these have been combined. Japanese rifles are of .256 and .303 caliber, the most commonly used being the .256 caliber. Machine guns usually employed by the Japanese are of .303 and .256 caliber. In this series there were 11 cases in which the men were wounded by rifle or machine gun fire; in 8 of these they were wounded by .256 caliber rifle fire. The exact specifications of weight, muzzle velocity and other characteristics of this rifle are not available to me, but the resulting wound is similar in many respects to wounds caused by the United States rifle. The wound of entrance is usually small, and the wound of exit is only somewhat larger unless bone is encountered. When bone is struck fragments of bone are often driven into the soft tissues, a larger area of tissue is damaged and therefore a large wound of exit results. The velocity of this shell is probably somewhat less than that of the American shell, as there seems to be more tendency for the bullet to lodge (fig. 1 *A*). Wounds caused by the larger (.303 caliber) shell are similar. In 3 cases the character of the wound was altered by the fact that the bullet struck some object on the soldier's person before penetrating. The fragments of the object struck were driven into the body, causing a larger, irregular wound of entrance. In 1 instance a knife handle was struck, in another a helmet and in the third instance a hand grenade, which fortunately did not detonate (fig. 1 *B*).

The most commonly seen wounds were caused by fragments of a Japanese 50 mm. mortar shell. Twelve men were wounded by this agent. The wounds caused by this weapon differ considerably from wounds caused by fragments of other artillery shells. The shell explodes on contact with considerable concussion. On detonation the wall of the shell disintegrates into many small fragments; there is even a powdering effect of some of the shell. The thin-walled brass detonator cap is also fragmented. When the soldier is wounded by the explosion of one of these shells at close proximity, the resulting wound is large and irregular and multiple small penetrations are seen at its base. The edges of the wound are blackened by many tiny powdery fragments which have been driven into the skin. At a greater distance dispersal of the fragments causes the resulting wound to consist of multiple widespread small perforations. Most of the powdery fragments have dissipated their velocity and are not seen. The fragments seen are portions of the cast iron wall of the shell,

which are irregular; they rarely measure over 1 cm. in diameter and usually lodge in the tissues. In addition, there may be thin fragmented strips of the detonator cap. These are irregular and rarely measure over 1 by 2 cm. (fig. 2 *A*).

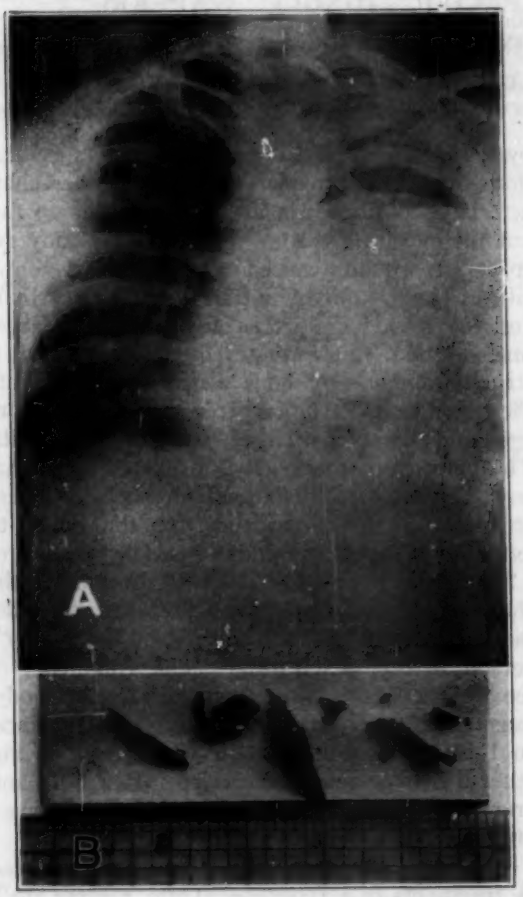

Fig. 1.—*A*, roentgenogram of the chest of a soldier wounded by a bullet from a Japanese .25 caliber rifle. *B*, fragments of the bullet and knife handle removed from the wall of the chest. The scale is in inches.

The roentgenologic appearance resembles a wound caused by a shotgun with irregular shot of varying size (fig. 2 *B*). Wounds caused by Japanese hand grenades are similar in many respects to wounds caused by 50 mm. mortar shells. The most common variety of grenade has a heavy brass top containing the pin and fuse (fig. 3 *A*). This top is usually not fragmented on detonation and apparently travels for a short distance only, as wounds caused by this object are rare. The wounds incurred close to the point of detonation are similar to those incurred near the burst of a 50 mm. mortar shell. The wounds incurred at a greater distance resemble the multiple perforations seen in those caused by the burst of a mortar shell at a distance (fig. 3 *B*). As there is no detonator cap, no thin metallic strips are found in the wound; the foreign bodies found are small, irregular and indistinguishable from the fragments of the wall of the mortar shell.[1]

Larger caliber artillery was not extensively used by the enemy in this engagement; however, in this series there were 4 cases in which the men were wounded by shell fragments of this type. A roentgenogram of the chest of a soldier wounded by the fragment of a 90 mm. mortar shell is pictured (fig. 4 *A*). These wounds were indistinguishable from wounds caused by a fragment of any high explosive shell, as was described by Bailey.[1] They were large, ragged and irregular, with an extensive area of damaged tissue. The foreign bodies were likewise large, irregular, heavy fragments, which often carried pieces of clothing into the wound and usually lodged (fig. 4 *B*).

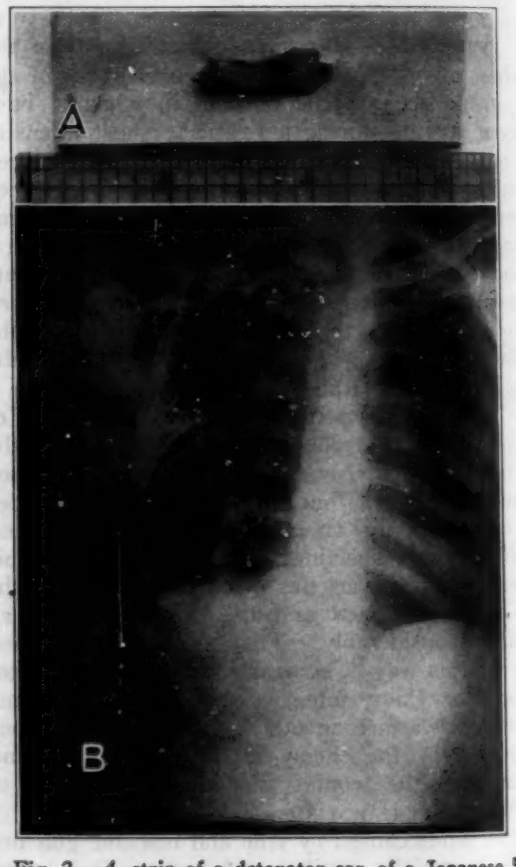

Fig. 2.—*A*, strip of a detonator cap of a Japanese 50 mm. mortar removed from the thoracic wall of a soldier. *B*, roentgenogram of the chest of a soldier wounded by fragments of a Japanese 50 mm. mortar.

It is frequently difficult to determine the exact causative agent of a penetrating wound. The wounds just mentioned were probably accurately

1. Bailey, H.: Surgery of Modern Warfare, Baltimore, Williams & Wilkins Company, 1941, vol. 1, p. 5.

classified by the patient's story and the character of the wound and foreign body (when the latter was available). In 3 cases, however, enough doubt as to the exact agent still existed that the wounds were left unclassified. They were

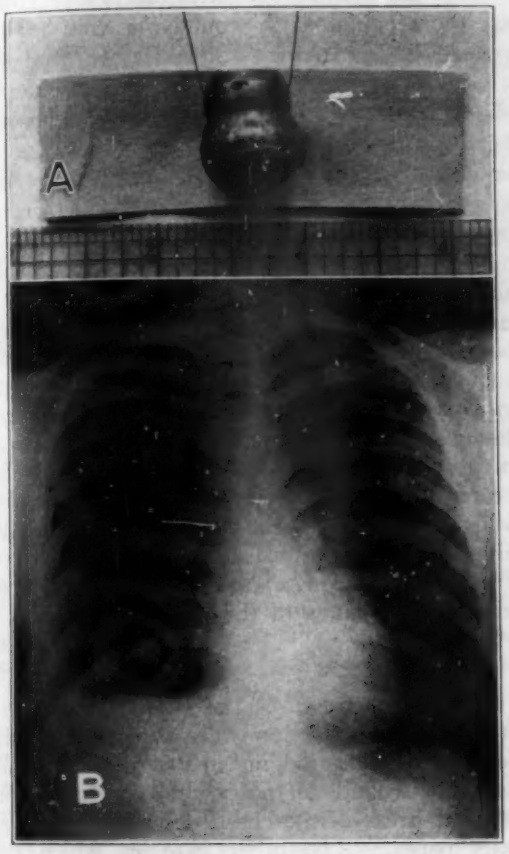

Fig. 3.—*A*, top of a Japanese hand grenade. This foreign body was removed from a soldier's neck. *B*, roentgenogram of the chest of a soldier wounded by fragments of a Japanese hand grenade.

probably caused by artillery fragments or exploding land mines.

Knife and bayonet wounds were not seen in this series; the ones seen in other campaigns differed in no striking way from knife wounds of the chest seen in civilian charity hospitals in large cities. There were no wounds caused by fragments of bombs. Wounds caused by shrapnel in the form of case shot were not seen in this area.

The importance of the location and course of a penetrating wound of the chest was emphasized in a previous publication.[2] I obtained no information in this engagement on those rapidly fatal wounds in which the heart or great vessels are penetrated. In only 1 case in this series was a patient wounded in a dangerous area. He must be considered fortunate, as small shell fragments passed through his hand before penetrating the sternum and lodging in the musculature of the left ventricle (fig. 5).

The soldier's general physical condition is obviously an important factor in his immediate response to the wound as well as in the healing process. This is even more true in warfare than in civilian life. The presence of such endemic diseases as malaria, filariasis and hookworm infestation, which are seen in this area, complicates the soldier's convalescence. More important are such factors as acclimatization of the soldier and the associated disturbances in the fluid and electrolyte balance and hypoproteinemia or temporary vitamin deficiencies, due to an isolated position.

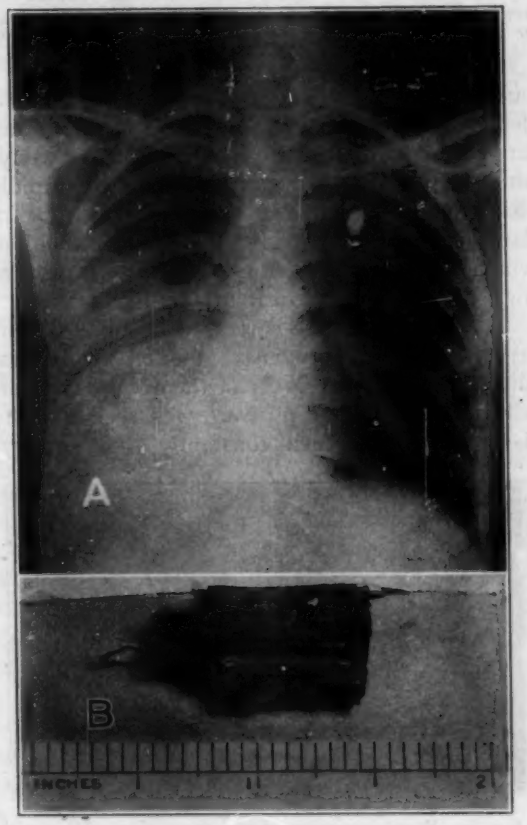

Fig. 4.—*A*, roentgenogram of the chest of a soldier wounded by a fragment of a Japanese 90 mm. mortar shell. The fragment penetrated the left side of the chest and lodged in the subcutaneous tissue of the posterior portion of the right side of the chest. *B*, fragment of artillery shell with attached piece of clothing removed from an infected pleural cavity.

An important factor in the character of the soldier's wound is the presence of an obliterated pleural cavity, resulting from previous pleural disease. When a thoracic wound is sustained by

2. Hardt, H. G., Jr., and Seed, L.: Comparison of the Course and Direction of Fatal and Nonfatal Gunshot Wounds of the Chest, War Med. **2**:623-634 (July) 1942.

a soldier with an obliterated pleural cavity, the blood cannot escape into the pleural cavity, so bleeding into the pulmonary parenchyma occurs, as has been well illustrated in the monograph of Duval.[3] Roentgenologically, clouding of the

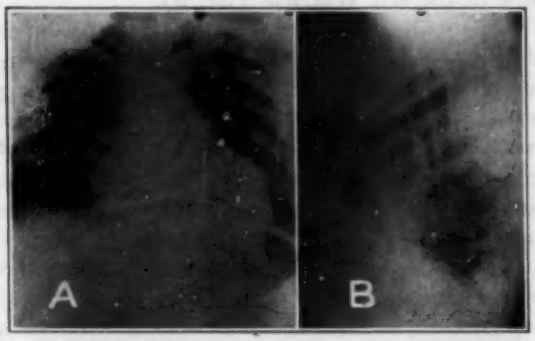

Fig. 5.—Roentgenogram of the chest of a soldier with hemopericardium, resulting from wounds caused by artillery shell fragments. *A*, posteroanterior view; *B*, lateral view.

pulmonary field in the region of the wound is demonstrable; the patient expectorates rather large amounts of blood during the first few days after being wounded and the clouding rapidly clears (fig. 6). Three cases of this type of damage were observed in this series, in all of which there was a history of previous respiratory disease with pleural involvement.

The soldiers whose cases are included in this series had been previously in excellent general physical condition. Most of them were combat-seasoned troops, and all were well acclimated to the tropics. All men constantly took prophylactic drugs for malaria. This regimen was continued in this hospital, and all remained free of symptomatic malaria. Two cases of hookworm infection were discovered in the routine examination for this parasite. Before and during the encounter the soldiers were adequately supplied with sufficient essential foods, fluids and vitamins.

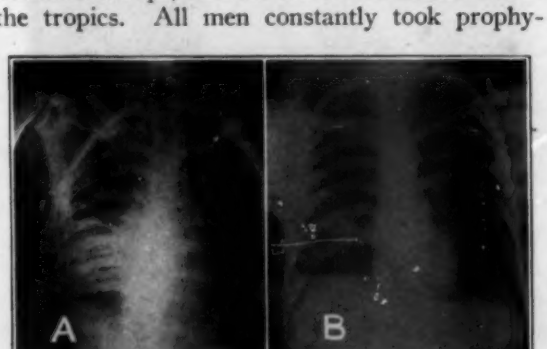

Fig. 6.—Roentgenogram of the chest of a soldier with hemorrhage into the pulmonary parenchyma, resulting from a wound caused by a bullet and a knife handle. *A*, taken immediately after the soldier was wounded; *B*, taken twelve days after he was wounded.

Early and adequate medical care for penetrating thoracopulmonary wounds is vital to the welfare of the patient. The series here reported is of interest because of the promptness and efficiency which characterized the handling of the men in the forward areas. Many of the patients arrived at an adequately established hospital within an hour after being wounded. Only 1 patient required more than four hours to reach the hospital, which contained adequate facilities and a well trained team for thoracic surgical operations. In this single exception, the patient's aid party encountered an enemy ambush, and the patient did not reach a hospital until twenty-four hours after he was wounded. Because of the circumstances and the tactical situation it will rarely be possible in this or any theater to have as adequate an organization available so near to the front. The results in this series of cases illustrate well the importance of early and adequate care in the treatment of penetrating wounds of the chest.

CLINICAL MANIFESTATIONS

In 9 of the 32 cases the wounds were perforating, and in 23 they were penetrating, with the foreign bodies lodging in the tissues. In 31 cases the wounds of entrance were located in the safer areas of the chest, described in a previous paper.[2] The other case in which the wound was located over the upper part of the sternum has been mentioned elsewhere. In 15 cases the wound of entrance was in the anterior portion of the chest, in 4 it was in the left axillary region, in 2 the right axillary region and in 11 the posterior portion of the chest.

Shock was severe in only 6 cases. In most of the cases the clinical evidence of shock was not prominent enough to warrant recording; however all of the patients were given at least 300 cc. of plasma intravenously on admission to the first hospital or in the aid station, regardless of their apparent good condition. It seems reasonable to assume that many cases of clinical shock were obviated by this prophylaxis. In the 6 cases in which there was clinical evidence of severe shock the patients were energetically treated with transfusions and plasma and responded well.

Hemoptysis was observed in 19 cases. It was slight and not frequently repeated except by those men with parenchymal bleeding, who were previously described. These men expectorated

3. Duval, P.: War Wounds of the Lungs: Notes on Their Surgical Treatment at the Front, New York, William Wood & Company, 1918.

blood for five or six days after being wounded. Dyspnea was noticed in 29 cases, but in 10 of these it was mild.

Hemothorax was present in 26 cases. It varied from the smallest amount detectable by roentgenogram to almost complete filling of the

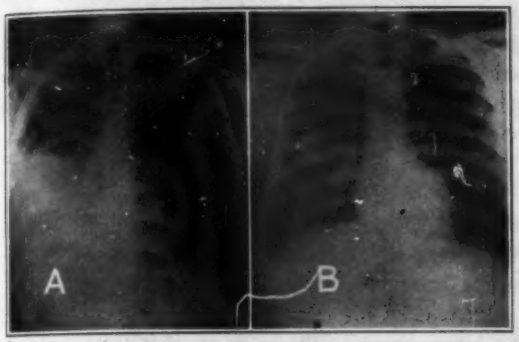

Fig. 7.—*A*, roentgenogram of the chest of a soldier wounded by an artillery shell fragment. Moderate hemothorax is present. The fragment is at the extreme base of the pleural cavity. *B*, roentgenogram of the chest of a wounded soldier, which demonstrates moderate pneumothorax without hemothorax.

pleural cavity (fig. 7 *A*). Pneumothorax in varying detectable amounts was present in 10 cases. In some cases pneumothorax was the dominant roentgenologic finding (fig. 7 *B*).

Fractured ribs were demonstrated in 10 cases; in 6 of these more than one rib was fractured. Perhaps other costal fractures existed, but exact evidence was obscured by the hemothorax. The scapula was fractured in 3 cases, the spine was fractured in 3 and the sternum and the clavicle were fractured in 1 instance each.

Subcutaneous emphysema was rarely encountered in this series.

COMPLICATIONS

In 1 case a bronchopleural fistula developed suddenly seven days after injury. The previously sterile hemothorax consequently became infected. Infected hemothorax developed in 2 other cases, in 1 of which it followed infection of the wound of the thoracic wall. The infected hemothorax in these 3 cases was drained surgically; in 2 resection of a rib was done, while in the third intercostal drainage was instituted. Hemolytic staphylococci were recovered from the infected pleural cavity in 2 cases and nonhemolytic staphylococci in the third. There were 3 instances of infection in the wound of the thoracic wall. The infection responded well to local therapy. In 2 cases evidence of pneumonitis in the injured lung was found. In these cases recovery was satisfactory after sulfadiazine therapy.

Local application of sulfanilamide crystals was used routinely for all wounds. The incidence of local infection was low considering the type of wound, but it is impossible to determine whether the local use of sulfanilamide was an important factor.

There were no deaths in this series of cases at this hospital. Information is not available regarding early deaths from wounds of the chest in the forward areas. There were 2 patients with damage of the thoracic portion of the spinal cord. These patients were sent to the rear areas in satisfactory condition, but their ultimate prognosis was considered poor.

All patients in this series of cases were evacuated by air over approximately 900 miles (1,448 kilometers). Twenty-four of these stated that they experienced no change of their respiratory symptoms during the flight. Seven patients admitted some increase in dyspnea at high altitudes, and 1 required oxygen. During one portion of the trip planes usually reach an altitude of at least 9,000 feet (2,743 M.). No untoward effects of evacuation by air were observed in any of these patients.

TREATMENT

The immediate treatment of the wounds consisted of application of sulfanilamide crystals locally and a dry dressing. Because patients arrived at a hospital so soon after being wounded, exploration and débridement of the wounds were done in almost every case. In 7 cases of open sucking pneumothorax the opening was closed. The pleural cavity was explored whenever extensive pulmonary damage or profuse bleeding was suspected. The wounds were closed primarily in 14 cases. Débridement was followed by application of petrolatum gauze and the wound was left open in 11 cases. Seven small wounds were treated by cleansing and dressing only. Crystals of sulfanilamide were frosted in every wound.

In spite of the fact that all of the wounds were seen early many of them were not closed primarily. This was due to the fact that many of the patients with wounds caused by mortar shells had such a large area of damaged tissue and so many foreign bodies that complete débridement could not be performed without removal of an excessive amount of soft tissue. These patients were treated by partial débridement, and the wound was packed open. The wisdom of not closing extensive wounds due to mortar shells was illustrated in 2 cases in which closure was attempted. Infection of the wound developed in both cases.

Secondary surgical operation was done for continued pulmonary bleeding in only 1 case.

In 3 cases the infected hemothorax was drained surgically. Exploration of the pericardial cavity for persistent hemopericardium was done in 1 case. Two wounds which had been packed open were closed secondarily.

Considerable variation of opinion has existed in medical literature regarding the care of hemothorax of traumatic origin. In this intermediary hospital the following indications for aspiration have been used, with satisfactory results:

1. Use aspiration and replacement with air during the first seventy-two hours after the wound is incurred if excessive dyspnea exists or if continued bleeding from the pulmonary parenchyma is suspected.

2. If a persistent daily temperature reaching 100 F. exists with no other source of fever present, aspirate the blood. Do not replace it with air.

3. Do diagnostic aspirations frequently.

4. Allow asymptomatic hemothorax to remain undisturbed.

None of the patients in this series were seen in this hospital within seventy-two hours after injury; hence aspiration and replacement with air were not used. They were used in 3 cases in the forward hospitals.

Diagnostic aspiration was done thirty-four times in 21 cases.

A daily elevation of temperature exceeding 100 F. developed in 4 cases in this series. Aspiration was done. In all of them the temperature promptly decreased. Subsequent roentgenograms in 3 revealed no reformation of fluid. In the fourth the patient had extensive hemothorax and effusion and was evacuated from the hospital for other injuries before the final result could be determined.

The described regimen of therapy has been used in all cases of traumatic hemothorax observed in this hospital. Aspiration for fever in the presence of sterile hemothorax has yielded similar good results in cases from other campaigns. In some cases in which effusion forms after aspiration, repeated aspiration may be required.

SUMMARY

A series of 32 cases is summarized to illustrate the types of penetrating wounds of the chest and the causative agents seen in Pacific jungle warfare.

Because of the multitude of foreign bodies and the large areas of damage to soft tissue caused by fragments of Japanese 50 mm. mortar shells and Japanese hand grenades, wounds of this nature are best treated by limited débridement and petrolatum gauze packing.

Plasma given early, prophylactically, proved to be a potent factor in decreasing the incidence of clinical shock.

Treatment of traumatic hemothorax in this intermediary hospital according to the outline presented gave satisfactory results. Patients with persistent fever and sterile hemothorax were successfully treated by aspiration alone.

Septic complications in this series were minimal.

No ill effects resulted from evacuation by air of patients with thoracopulmonary wounds.

A LABORATORY COURSE IN THORACIC SURGERY

EXERCISES IN THE PERFORMANCE OF SURGICAL PROCEDURES ON THE THORAX WITH A DISCUSSION OF THEIR CLINICAL APPLICATIONS

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AND
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The various operations employed in thoracic surgery, simple as well as complex, are easily demonstrated and performed on living anesthetized animals. In a course in thoracic surgery designed for members of the Army Medical Corps, we demonstrated the procedures, which were then performed on animals by the members of the class.

The animals (dogs) are anesthetized with intravenously administered pentobarbital sodium (35 mg. per kilogram of body weight). Adequate respiratory exchange is maintained by introducing a no. 28 (French) rectal catheter into the trachea and connecting it with a positive pressure apparatus. Should the pentobarbital sodium become ineffective, ether is administered through this apparatus. Although the operations were performed on anesthetized animals, the following discussions and descriptions of technic accompanying each procedure refer to human subjects.

1. ASPIRATION OF THE CHEST

Practical Exercise.—Aspiration of the chest is performed on an anesthetized animal with the following points in mind.

Clinical Considerations.—Aspiration is more comfortably and more accurately performed with the patient in the sitting position, if practicable, and the patient's feet over the side of the bed supported on a chair; an assistant is assigned to the sole duty of supporting the head and shoulders of the patient. Previous moderate sedation is desirable to allay apprehension and cough. Figure 1 shows the sterile instrument tray provided for aspiration. This sterile tray should contain two straight hemostats, 1 thumb forceps, a no. 11 Bard-Parker blade, a 10 cc. syringe with a hypodermic needle and a long fine needle for deeper infiltration of the tissues with procaine hydrochloride and a 50 or 30 cc. syringe with a large aspirating needle with a short bevel and a two way stopcock or a 3 inch (7.6 cm.) rubber tube interposed between the syringe and the needle.

Since aspirations must occasionally be repeated, they should be painless and of course aseptic. The painlessness is particularly important for children. Gloves are not necessary. Gloves used under the conditions surrounding an aspiration are soon contaminated and become a menace rather than a protection. The various articles on the instrument tray are not removed with the fingers but with a sterile thumb forceps, so as to maintain the sterility of the tray throughout the procedure.

The site of aspiration for the purpose of removing fluid depends in general on the clinical signs, but when it is performed for the relief of dyspnea the needle is inserted in the posterior axillary line in the seventh interspace or above, to avoid injury to the diaphragm, which may be high.

The skin at the site selected for aspiration is infiltrated with 1 per cent procaine hydrochloride solution, with a fine hypodermic needle; this is followed by infiltration of the deeper intercostal tissues with a long fine needle. The skin is incised for 1 mm. with a no. 11 Bard-Parker blade, to avoid passing the aspirating needle through potentially infected hair follicles and sebaceous glands. An aspirating needle of large bore is introduced through the anesthetized area; it must hug the upper border of the lower rib to avoid the neurovascular bundle which lies along the inferior border of the rib. When severe pain accompanies aspiration, it is evident that this precaution has not been observed. Resistance is encountered as the needle penetrates the tissues. After the needle has encountered fluid, it is advanced 2 mm. more, and a small hemostat is placed on the needle flush with the skin so that the needle can be fixed in this position throughout the aspiration.

This course was given in the surgical laboratory of the Stanford University School of Medicine in November 1942, April 1943 and again in June 1943.

The opinions contained herein are the private ones of the authors and are not to be construed as official or as reflecting the views of the Navy Department or of the naval service at large.

If available, a two way stopcock is interposed between the syringe and the needle, which permits controlled discharge of fluid into a container and regulation of the introduction of air, if this is found desirable. If a stopcock is not available, a small segment of rubber tubing is interposed between the syringe and the needle, which may be clamped by a hemostat when the syringe is detached for discharge of fluid; hence an air-tight system is maintained throughout the aspiration. Moreover, accurate measurement of the amount of air and fluid removed from the chest is made possible.

If the fluid is amber but clear, only enough fluid is aspirated—about 75 to 100 cc.—for diagnostic studies: culture, determination of specific gravity and cell count, acid-fast and gram staining of the centrifugated sediment and injection of fluid into a guinea pig.

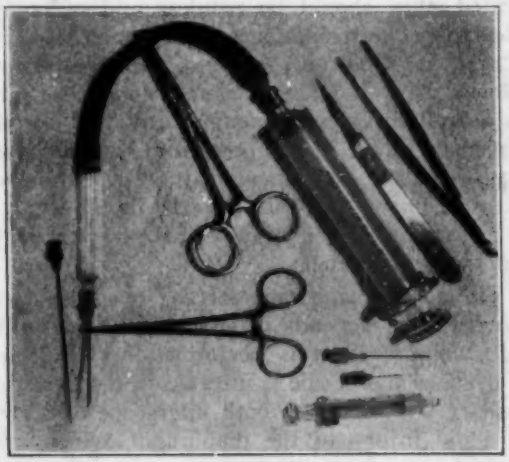

Fig. 1.—Sterile instruments needed for aspiraton of fluid from the chest: a 5 or 10 cc. syringe, one hypodermic and one no. 22 needle, a thumb forceps, one no. 11 Bard-Parker blade, two hemostats, two aspirating needles of wide bore and short bevel no. 15 and no. 18, and one 30 or 50 cc. syringe with a short rubber tube and a glass adapter interposed between the needle and the syringe. (See text for technical details.)

If the fluid is bloody, as with cancer of the pleura or lung, about 200 cc. is aspirated, diagnostic studies are performed and the fluid is centrifugated to obtain a "button" of cells for embedding in paraffin and for subsequent microscopic section.

If the fluid is foul-smelling or obviously purulent though thin, immediate, continuous intercostal air-tight tube-under-water drainage is instituted (section 3).

If the pus is thick with much fibrin and restricted to a localized area, according to roentgenograms, resection of a small segment of rib or a short intercostal incision for washing out the fibrin and for the insertion of a mushroom-tipped catheter is in order (section 4).

Clear amber fluid obtained from a chest in the presence of a high temperature and unilateral abdominal symptoms, after an abdominal operation or an acute abdominal episode, suggests a subdiaphragmatic or an intrahepatic abscess.

Fluid in the chest following a penetrating wound is due either to bleeding or to effusion. The mere presence of blood may not be harmful, but if it and air, or air alone, fill an entire hemithorax and produce dyspnea and circulatory embarrassment by a shift of the mediastinum aspiration is urgently indicated. Aspiration of air alone in pneumohemothorax may be sufficient to control the dyspnea. If aspiration is found necessary within twenty-four to forty-eight hours after injury, only enough blood is removed to control the dyspnea to a point of comfort, since further aspiration may reopen bleeding points. Usually the removal of 400 to 500 cc. of blood will suffice. We do not believe that replacement of blood by air is necessary or desirable, as it is difficult to understand how a bleeding vessel can be more effectively closed by pressure due to air than by pressure due to hemothorax. Moreover, we believe that early reexpansion of the upper lobe is most important in reestablishing normalcy in the chest and should not be interfered with or delayed by the introduction of air. Not infrequently fluid which may at first be extremely bloody or serosanguineous later becomes purulent. Development of empyema in the presence of a collapsed lung may introduce the additional hazard of failure of reexpansion of the lung. Air free in the thorax tends to produce a collapse of the upper lobe. In the presence of pus the inflamed visceral pleura becomes thickened and rigid, and in this state the upper lobe may become fixed by adherence along the similarly inflamed mediastinal pleura. When this occurs its reexpansion is most difficult and may be greatly delayed or even prevented entirely (fig. 2). Thoracoplasty may be necessary before complete cure can be effected.

If dyspnea promptly recurs after the initial aspiration of blood for dyspnea, it is evident that bleeding is still severe, and a thoracotomy may be indicated to control it (section 9). Such bleeding may be due to wounds of the intercostal, internal mammary, hilar or mediastinal vessels. The blood may also come from a laceration of the lung, the pericardium or the heart, or it may even come through a rent in the diaphragm, resulting from injuries to such intra-abdominal structures as the liver. The site of the wound and a roentgenogram disclosing the location and probable course of a retained foreign body will assist in determining what structures may be involved.

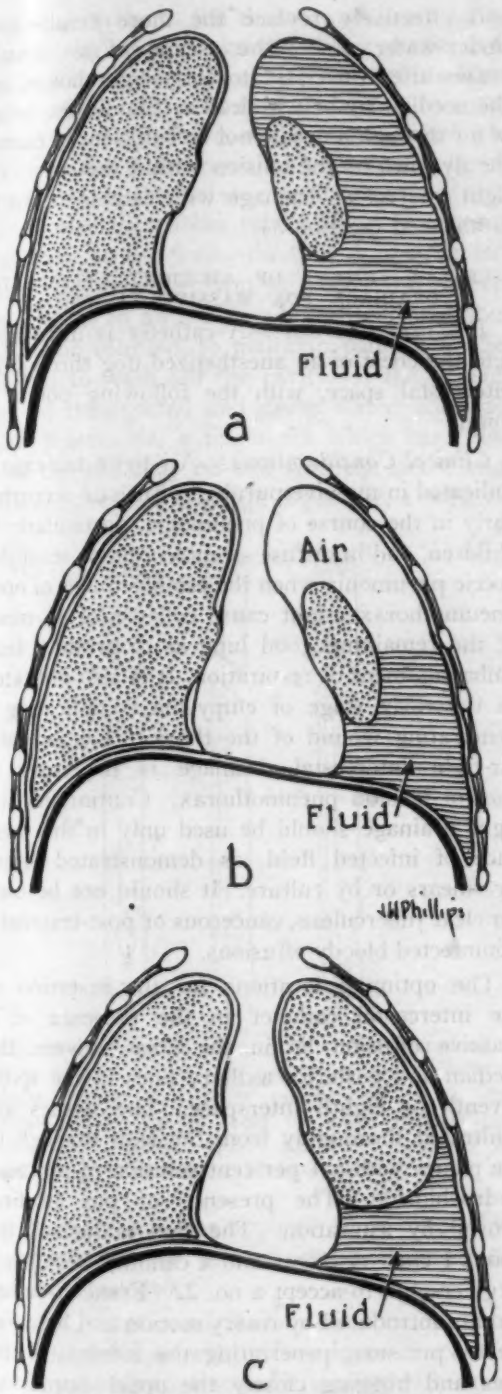

Fig. 2.—(*a*) Large effusion into the left side of the chest. (*b*) Partial aspiration of fluid and replacement by air. In an active patient accustomed to sitting up, air tends to accumulate at the top of the pleural space and fluid at the base. Development of empyema then threatens fixation of the upper lobe in the collapsed state by inflammatory adherence of the visceral and mediastinal pleuras, thus greatly complicating elimination of the empyema cavity by reexpansion of the lung. (*c*) After aspiration without replacement by air, fluid tends to accumulate at the base, the upper lobe reexpands, the pleuras usually become adherent with the lung expanded and if empyema develops it is localized rather than massive.

In the aspiration of fluid that has been present in the chest for some time, it is desirable not to remove more than 500 cc. at one sitting or to remove any beyond the point where pain is produced. If pain occurs, sufficient air should be introduced through the aspirating needle to control it, but in general replacement of serosanguineous fluid by air serves no useful purpose and should not be done, for reasons outlined previously. Occasionally, it may be desirable to introduce 100 to 150 cc. of air after partial aspiration to aid the roentgenologist in outlining a cavity or in bringing the contour of the intrathoracic structures into relief.

Fluid obtained by aspiration should be subjected to the following studies: making of a culture, determination of red and white cell counts and of hemoglobin content and immediate staining of a smear on a slide for detection of organisms. If aspirations are again necessary, these studies should be repeated after each aspiration. The information so gained may determine the further course of treatment. If the concentration of blood remains high at the second aspiration for dyspnea, it may be evidence of continued bleeding, which may require thoracotomy for its control. If fluid is less concentrated at the second aspiration, effusion is indicated and bleeding has probably ceased. If organisms are found in the smear, early empyema is suspected, and prompt establishment of air-tight intercostal continuous drainage will shorten convalescence greatly.

In general, hemothorax without symptoms, even though it is extensive, may be disregarded in the early period following injury. Remarkably rapid absorption of even large collections of blood has been observed. If there is no evidence of absorption after two or three weeks, aspiration becomes necessary and may need to be repeated. Alteration in relations of pressure within the thorax after one aspiration may lead to absorption of the remaining fluid. On rare occasions massive hemothorax may clot and can be evacuated only by thoracotomy, followed by immediate closure of the operative wound without drainage. Blood which has a tendency to clot immediately on aspiration suggests a massive injury to the lung or pleura or an incipient infection.

2. INSERTION OF NEEDLE FOR TENSION PNEUMOTHORAX

Practical Exercise.—A needle is inserted into the chest of an anesthetized animal and 400 to 600 cc. of air introduced with a syringe to which a two way stopcock has been attached. Enough air is introduced to produce increasing dyspnea. The needle is withdrawn, and the chest is aspi-

rated by inserting a needle to which a piece of rubber tubing has been attached. The rubber tube is placed under water to show the escape of air.

Clinical Considerations.—Severe dyspnea occurring promptly after injury may be due to tension pneumothorax incident to a laceration of the lung, bronchus or trachea, to a sucking wound without escape of air or, even more commonly, to a crushing injury of the chest in which it may not be suspected. Distinct high-pitched resonance on percussion with absence of breath sounds indicates pneumothorax. After anesthetization of the tissues with procaine hydrochloride the aspirating needle is usually introduced anteriorly in the second or third inter-

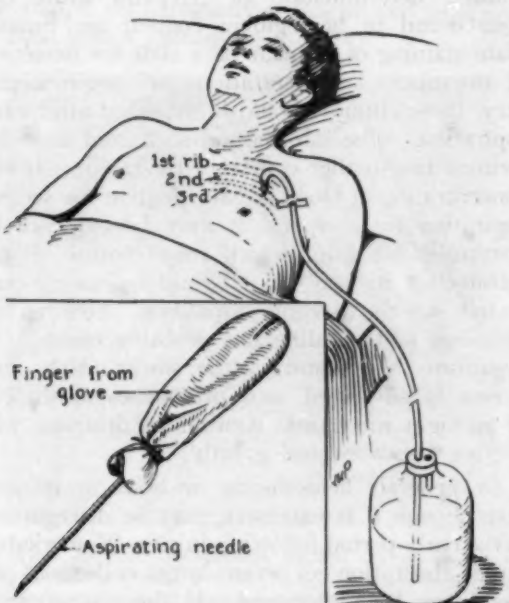

Fig. 3.—Aspiration of air from the chest through the second or third interspace anteriorly in or just lateral to the midclavicular line. Constant escape of air under water may need to be provided. When transportation is necessary, a finger cot (the tip of which has been slit) should be tied to the end of the needle and the needle fixed to the thoracic wall with adhesive tape. No dressing is necessary unless fluid escapes as well.

space in the nipple line. There may be a whistling release of pressure through the needle and prompt relief of the dyspnea. If air continues to escape, the needle should be connected with a rubber tube for continuous under-water drainage (fig. 3). If the patient is to be transported, instead of rubber tubing a soft rubber finger cot, a finger of a rubber glove, or a soft rubber sheath perforated at the end should be applied to the needle. This will permit the escape of air but prevent its reentry during inspiration and effectively replace the more cumbersome under-water seal. The escape of air usually ceases after thirty-six to forty-eight hours, and the needle may be withdrawn. Should the escape of air through a needle not be sufficient to control the dyspnea or the tension within the chest, air-tight intercostal drainage with catheter must be established (section 3).

3. ESTABLISHMENT OF AIR-TIGHT INTERCOSTAL DRAINAGE FOR MASSIVE EMPYEMA

Practical Exercise.—A catheter is introduced into the chest of an anesthetized dog through an intercostal space, with the following points in mind:

Clinical Considerations.—Air-tight drainage is indicated in massive purulent effusions occurring early in the course of pneumonia, particularly in children, and in diffuse streptococcic or staphylococcic pneumonia when the establishment of open pneumothorax might cause collapse of so much of the remaining good lung as to produce fatal embarrassment of respiration. It is also indicated in the early stage of empyema complicating a penetrating wound of the thorax. Occasionally air-tight intercostal drainage is necessary to control tension pneumothorax. Continuous air-tight drainage should be used only in the presence of infected fluid, as demonstrated either by smears or by culture. It should not be used for clear tuberculous, cancerous or post-traumatic noninfected bloody effusions.

The optimum locations for the insertion of the intercostal catheter in the presence of a massive effusion lie in the area between the median and posterior axillary lines in the sixth, seventh or eighth interspace. The tissues are infiltrated thoroughly from the skin through to the pleura with a 1 per cent solution of procaine hydrochloride. The presence of pus is first proved by aspiration. The skin is incised for about 1 cm. A trocar and a cannula, which are large enough to accept a no. 22 (French) catheter, are introduced by rotary motion and by slow, steady pressure, penetrating the intercostal tissues and hugging closely the upper border of the lower rib. The catheter is prepared before insertion by making two additional lateral openings near the tip on opposite sides of the catheter (fig. 4). Two results are achieved thereby: (*a*) These openings provide a flexible tip which will not erode the lung as the latter reexpands, as would a hard, rigid tube; (*b*) three apertures in the catheter insure drainage through at least one opening should the other two be covered by a reexpanding lung or by fibrin. The catheter is

attached securely to the thoracic wall, not by a suture through it but by narrow strips of adhesive tape applied around the catheter and to the thoracic wall; these narrow strips are in turn fixed in place by broad straps of adhesive tape applied to the thoracic wall. A glass Y tube is introduced into the catheter, with one arm of the Y to receive the rubber tube leading to a large glass bottle on the floor—the tube is to be under water—and the other arm to receive the rubber tube leading to an infusion bottle for irrigation with saline solution, to maintain patency of the tube and to wash out the cavity. If the patient must be transported and under-water drainage is not practicable, a finger cot which has been slit at the end may be tied securely to the end of the catheter. If drainage is profuse, a volumi-

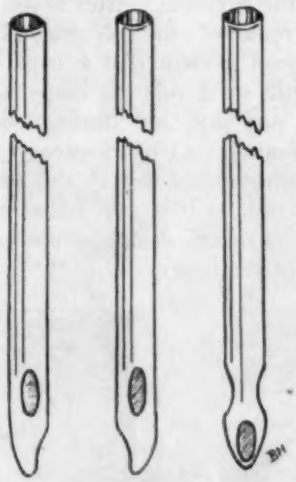

Fig. 4.—Preparation of a catheter for introduction into an intercostal space to provide air-tight drainage includes cutting two holes on opposite sides just proximal to the tip, in order to insure at least one opening for drainage should the other openings be closed by overlying lung or fibrinous folds.

nous dressing must be applied. If drainage with a catheter is for tension pneumothorax, no dressing is needed.

If pus is thick and fibrinous it may be desirable to insert a second catheter in another intercostal space for continuous irrigation with saline solution, aqueous solution of chloroazodin or diluted solution of sodium hypochlorite. After six to ten days the original catheters may become loosened and may be replaced with larger-sized catheters to maintain air-tight drainage. When the empyema becomes limited by pleural adhesions, it may be necessary to enlarge the opening of the catheter in the intercostal space or to resect a segment of rib for more adequate and complete drainage.

4. OPEN DRAINAGE FOR LIMITED OR LOCALIZED EMPYEMA BY INTERCOSTAL INCISION OR BY RESECTION OF A RIB

Practical Exercise.—Resection of a rib of an anesthetized animal is performed, with the following points in mind:

Clinical Considerations.—When empyema is limited by visceroparietal pleural adhesions, open drainage is indicated for prompt and complete evacuation of pus. The site for dependent drainage by aspiration is determined, with the lowest needle through which pus has been obtained being left in place. A short intercostal incision is made, with the area under local anesthesia, or a 3 to 4 cm. segment of rib is excised. It is important not to strip periosteum from rib that is not removed; that is, all rib denuded of its periosteum must be excised to avoid osteomyelitis of the exposed devitalized rib. When available the cutting cautery may be used in mobilizing the rib and its periosteum. The pleura may also be incised with the cutting cautery, a small segment of the parietal pleura being removed for microscopic study. This is important to avoid missing the recognition of empyema due to tuberculosis. Bleeding points are controlled by ligatures, and sulfonamide compounds in powdered form are liberally applied to the cut costal surface and to exposed tissues before the pleura is incised and before pus is permitted to contaminate the tissues. Several methods for maintaining drainage are available: After complete evacuation of the cavity of all masses of fibrin and pus, a large mushroom-tipped catheter drawn flush with the parietal pleura may be inserted, and semiclosed drainage may be maintained. A soft rubber tube, 8 to 10 mm. in diameter and 10 to 12 cm. long with the ends open and two lateral openings near the inserted end, may be used. A safety pin through the tube outside the thorax permits fixation of the tube. A finger cot with the distal tip slit for 2 cm. is fastened to the end of the tube by a circular ligature (fig. 5). The wound is semisealed with petrolatum-treated strips and massive dressings applied under a circular chest binder. No suturing of the wound is necessary.

5. SEMIOPEN DRAINAGE OF CHRONIC EMPYEMA BY SUTURING A SKIN FLAP TO THE PARIETAL PLEURA (ELOESSER)

Practical Exercise.—A skin flap is prepared, the rib is resected and drainage is established for presumed chronic empyema, with the following points in mind:

Clinical Considerations.—The establishment of a semiepithelized drainage tract provides an opening during cough and forced expiration but

closure during inspiration; this will create conditions that will gradually expand a lung long collapsed by chronic empyema, whether pyogenic or tuberculous in origin.

Several considerations determine the location of the flap (fig. 6):

The base of the U-shaped flap should lie above the apex. The base is customarily 3 to 4 inches (7.5 to 10 cm.) across, with the length variable, but also approximately 3 to 4 inches and the apex is usually about 1½ inches (4 cm.) in width. It should be placed so as to provide dependent drainage with the patient in the upright position. This may be determined by roentgenograms taken after the introduction of

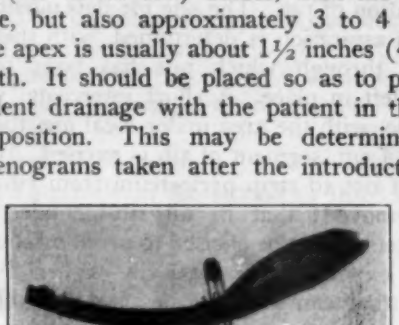

Fig. 5.—"No back draft drain": rubber tube with two lateral and one terminal opening for insertion into the empyema cavity, the exterior end of which is covered with a finger cot or a finger of a glove the tip of which has been split, which permits escape of pus but prevents entrance of air into the cavity.

a contrast medium, like iodized poppyseed oil, through a sinus tract, by a thoracotomy wound or by an aspirating needle—or by aspiration at different intercostal levels. If the empyema involves the lower part of the chest, the flap must lie at least a rib and an interspace above the diaphragmatic attachment to the thoracic wall, so that the subsequent tendency of the diaphragm to rise will not occlude the opening. The flap should not be placed over the scapula or near the lower angle of the scapula, since motion of the shoulder girdle would tend to displace the apex of the flap from its attachment to the parietal pleura. The flap is so placed that the rib to be excised lies at the junction of the upper and middle thirds of the flap. If shrinking of the rib cage has occurred, due to the underlying inflammation, it often is desirable to remove small segments, 1½ inches (4 cm.) long, of two ribs. The ribs are mobilized, preferably with a cautery, so as to avoid early regeneration of the rib. A rectangular area of the parietal pleura beneath the excised ribs is removed with the cautery. The excised portion of the pleura must be sufficiently large so that the apex of the flap does not completely occlude the opening. A specimen of the excised pleura should be sent to the laboratory for microscopic study. If segments of two ribs have been removed it is advisable to excise the neurovascular bundle below the upper excised rib. The distal third of the flap is then denuded of its subcutaneous fat. The apex of the flap is sutured with two or three mattress sutures of silk or cotton to the upper border of the defect in the thickened parietal pleura, with small, full-curved cutting needles. No attempt whatever is made to close the raw surface produced by this maneuver. To facilitate immediate drainage and to promote adherence of the flap to its new bed, a short rubber tube, about 3 inches (7.5 cm.) long, is inserted through the thoracic wall, to the external end of which is tied the finger of a rubber glove the tip of which has been slit (fig. 5). Petrolatum-treated strips are applied to the tip of the flap, snugly around the tube and over the raw surface of the wound. A large pad held in place by a tight binder completely encircling the chest completes the dressing. After seven to ten days the tube is removed; the hole gradually contracts, and it is soon evident that a negative pressure is being built up inside the empyema cavity by escape of pus and air during coughing and forced expiration and by closure of the opening during inspiration. Even in the presence of a bronchial fistula it has been found efficacious in providing adequate drainage and gradual reexpansion of the lung.

Fig. 6 (Patient A. N.).—(*a*) Eloesser flap two days after operation, on Jan. 19, 1944, for drainage of a posterior empyema cavity, which followed an abdominothoracic gunshot wound of the lower portion of the chest. Small 3 cm. segments of the seventh and eighth ribs were removed. Note the size of the resulting wound and the absence of sutures except three invisible ones, which approximated the tip of the skin flap to the parietal pleura. (*b*) Appearance of the rapidly closing external wound on February 5, within nineteen days after operation.

6. PENETRATING WOUNDS OF THE THORACIC WALL

Practical Exercise.—An anesthetized animal is prepared for this exercise by removal of a portion of one rib to create a sucking wound. The dangerous effects of such a wound are demonstrated by withholding temporarily the positive pressure anesthesia. Severe dyspnea incident to the transfer of atmospheric pressure

to the intact sound side by a flexible mediastinum is at once apparent. The varying effects of the size of the sucking wound are also demonstrated.

Clinical Considerations.—If only a single wound of entrance is present, a roentgenogram of the chest and a scout film of the abdomen should precede definitive treatment to ascertain the location of the foreign body. Emphysema of subcutaneous tissues and hemoptysis, however slight, give evidence of a contused or lacerated lung, bronchus or trachea. Emphysema of the mediastinum may be productive of great dyspnea and may be fatal. A rapidly spreading emphysema of the neck usually accompanies mediastinal emphysema, both of which may be relieved by an incision made just above the sternum. After sharp division of the skin and platysma muscle, the tissues are spread by blunt dissection, and separation of the sternohyoid muscles in the midline gives access to the loose areolar and fatty tissue just above and posterior to the upper border of the sternum. Blunt and digital separation

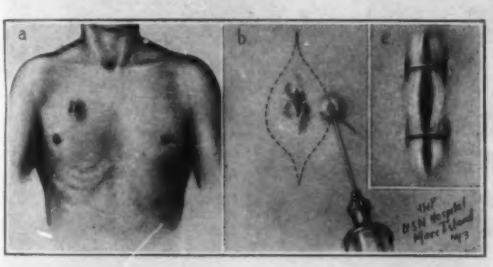

Fig. 7.—Jagged wounds of entrance or exit should be excised under local anesthesia and closed with widely spaced sutures or left unsutured if the sucking hole in the thoracic wall is easily controlled by a petrolatum dressing.

of these tissues will avoid traumatizing thin-walled veins in this area. A soft rubber tube or a tissue drain is introduced to permit continuous escape of air.

Severe bleeding from the mouth is not easily controlled, but the precaution must be observed of placing the patient with the head and thorax dependent, to facilitate drainage and to avoid his drowning in his own blood. Administration of large doses of morphine is indicated to allay apprehension and to decrease respiratory movement.

Small cleancut wounds of entrance and exit without powder burns or obvious devitalization of skin require simple dressing only. Jagged wounds with obvious traumatization of skin and underlying tissues require débridement and loose closure (fig. 7) to prevent local infection, spreading phlegmon of the thoracic wall or extension to an underlying hemothorax. Local anesthesia is employed, with the tissues to be infiltrated well away from the area of injury so as not to neutralize the sulfonamide compounds which will later be introduced into the wound. Devitalized tissue is excised, and foreign material and bits of unattached fragments of rib are removed (fig. 8). Sulfonamide drugs in powdered form are introduced liberally to every nook and cranny of the wound, by mixing the powder with tissue fluid and blood and smearing this suspension throughout the wound with the gloved finger or instrument. Muscles are closed loosely with few sutures, the skin may be left open or closed loosely and petrolatum gauze and a firm dressing are applied. If the wound is limited to the thoracic wall without communication with the pleural cavity or if only a small opening exists which can easily be controlled with gauze, the wound should be lined with petrolatum or sulfathiazole gauze and a firm dressing applied without the use of sutures.

Large open wounds of the thoracic wall suck in air with each respiration. This collapses the lung on the side of the lesion instead of inflating it. In young persons the flexible mediastinum will shift with inspiration to the uninjured side because of negative pressure on that side. This still further reduces expansion of the lung and aeration of the blood, and severe dyspnea, if not death, is the inevitable result. Closure of these wounds is, therefore, imperative and life saving. If facilities for an operation are not immediately available, the wound must be covered or filled with petrolatum or plain gauze and the dressing held firmly in place by adhesive tape straps or broad bandages completely encircling the chest. Occasionally it may seem desirable to close such a wound immediately under local anesthesia. After closure it is desirable to remove as much air as possible from the pleural space by simple aspiration of the chest.

Occasionally, also, a small perforating wound will suck air but prevent its escape, with the result that positive pressure or tension pneumothorax is built up. This may be even more dangerous to life than a wound that permits both sucking and escape of air. The great need of early recognition of such a mechanism is obvious, as it may be necessary temporarily to enlarge such a wound to permit escape of air until complete closure by operation or by dressing can be performed.

7. CARE OF SUCKING WOUNDS COMPLICATED BY INTRATHORACIC INJURIES

Practical Exercise.—Through a thoracotomy incision, the lung and the hilar tissues are exposed, a laceration of the lung is repaired, a

partial and a complete lobectomy are performed and the hilar vessels to a lobe are individually ligated. The phrenic nerve is identified as it courses over the pericardium, is pinched to illustrate contraction of the diaphragm and then crushed to demonstrate relaxation and elevation of the diaphragm. The diaphragm is incised in the direction of its muscular fibers and the abdomen explored through the opening. A tear of the liver is produced, and bleeding is controlled by muscle tamponade or by gauze packing, the gauze emerging through a separate stab wound in the lateral abdominal wall below the diaphragm. Drainage of a large tear in the liver is effected by soft rubber tissue drains, which also escape from a separate opening in the abdominal wall. A tear in the stomach is produced and repaired. Transpleural-transdiaphragmatic splenectomy is performed. A segment of small bowel

If enlargement of the existing wound by an intercostal incision permits adequate inspection of the pleural cavity, this may be done. If not, the wound should be debrided and closed after exploratory thoracotomy has been performed through a site of election. For exposure of the lower part of the chest and diaphragm, an incision in the posterolateral portion of the eighth interspace is effective (section 10). For exposure of the anterior portion of the chest and the hilus, an anterior incision through the fourth interspace with division of the fourth and third costal cartilages will suffice (section 9).

After an intercostal incision is made the ribs are spread with a self-retaining retractor. The fluid and the clotted blood are sucked out. Bleeding from intercostal, internal mammary, hilar or mediastinal vessels or from a lacerated lung should be searched for. Bleeding points are con-

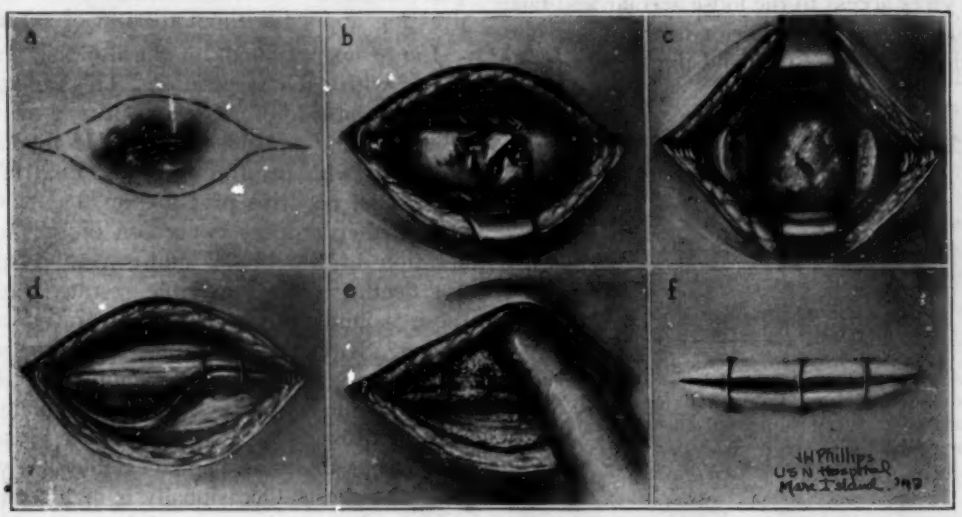

Fig. 8.—More extensive injuries to the thoracic wall involving the rib cage are treated by excision of traumatized skin, removal of unattached rib fragments, application of powdered sulfonamide drugs by smearing a suspension into all corners of the wound, overlapping of musculature to close the sucking wound and loose or no closure of the cutaneous wound.

may be resected and an aseptic end to end anastomosis performed with the Martzloff [1] modification of the Parker-Kerr technic.

Clinical Considerations.—Operation is best performed with the patient under some form of closed anesthesia, preferably given by the intratracheal route, which permits positive inflation of the lung when the thoracic wall is open. Suction for clearing bronchi is also highly desirable if not imperative.

1. Martzloff, K. H., and Burget, G. E.: Closed Intestinal Loop: Aseptic End-to-End Intestinal Anastomosis and Method for Making Closed Intestinal Loop Suitable for Physiologic Studies, Arch. Surg. **23**: 26-37 (July) 1931.

trolled with suture ligatures. The pulmonary artery or any of its branches may be ligated with impunity, since nutrition of the lung is maintained through the bronchial artery and its branches ramifying through the bronchial walls. If the pulmonary vein requires ligation, the pulmonary artery should likewise be ligated to avoid active congestion of the lung. Both the pulmonary artery to and the pulmonary veins from a lobe or a lung may be ligated without removing the lobe or the lung. A rent in the vena cava has been successfully sutured.

A laceration of the lung may require trimming with scissors of devitalized tissue (fig. 9), application of powdered sulfonamide drugs and

suturing of the laceration with a continuous right-angled hemostatic lock stitch (fig. 10).

Partial resection of a lobe may be necessary for a mangled lung (fig. 11). A rubber-shod intestinal clamp or a hilar tourniquet, if available, may be applied across the hilus of the lobe for temporary control of bleeding. A second intestinal clamp is applied just proximal to the traumatized lung. Before excision of the damaged lung, which may be used for retraction and steadying of the lung, a continuous "cobbler's" stitch is applied proximal to the second clamp. A "cobbler's" stitch is one in which two needles which are full curved, round and noncutting are attached to the same suture, the two needles

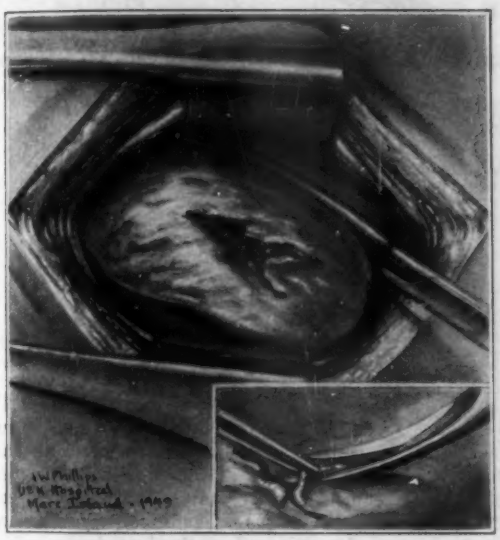

Fig. 9.—A laceration of the lung with moderate escape of air and blood may be excised and closed (fig. 10). The lung may be clamped proximally with rubber-shot intestinal clamps for temporary control of bleeding and escape of air. If escape of blood and air is easily controlled by deflating the lung, no sutures need to be applied. The chest is closed with the lung deflated and partial pneumothorax.

being introduced back and forth through the lung proximal to the clamp, the suture being drawn tight each time and both vessels and bronchi thus being effectively closed (fig. 12). The damaged lung should be excised close to the clamp. The distal clamp is removed and the raw surface of the lung closed with an over and over stitch. These two sutures should be made with no. 0 chromic catgut on atraumatic needles, if available. The suture line is tested by inflating the lung and dropping water on it with a syringe. Bleeding points or leaking bronchi are controlled with individual reenforcing sutures. If air and blood escape from the suture line when the lung is fully expanded, the lung should be deflated to a point where no leakage occurs and the wound in the thoracic wall closed with the lung partially collapsed. Air may be aspirated five to seven days later. Sulfonamide drugs in powdered form are applied to all exposed pleural surfaces, to the raw pulmonary surface and along the suture line. If penicillin is available, its introduction into the pleural cavity followed by parenteral administration for several days is indicated in doses of not less than 100,000 units daily. In case of minimal damage to the lung

Fig. 10.—Closure of a laceration of the lung by a continuous right-angled, deeply applied suture of catgut on an atraumatic curved fine intestinal needle. After removal of the clamp and inflation of the lobe, the suture line is tested by dropping water on it. Leaks are reenforced with deeply placed interrupted sutures. If leakage of air is general from every stitch hole, the lung is collapsed to a semi-inflated state and the thorax is closed with partial pneumothorax, to be eliminated by aspiration several days later.

and slight contamination with foreign material, drainage is not necessary. When partial lobectomy is performed or when gross contamination with soil and clothing has occurred, a mushroom-tipped catheter is introduced in the intercostal space independent of the line of incision for air-tight drainage of the pleural cavity after closure of the wound (fig. 13).

If inspection of the lower portion of the thorax reveals a penetrating wound of the diaphragm,

the opening should be enlarged to permit exploration of the abdomen and underlying viscera. A roentgenogram taken previously will have established the location of the foreign body and possible injury to the viscera in line of its probable travel. Laparotomy is indicated in the presence of evidence of a perforated viscus that cannot be approached through the rent in the diaphragm. A large tear of or an injury to the liver must be drained to the outside with soft rubber tissue drains or packed if necessary to control bleeding, the drains and packing emerging through a separate stab wound in the abdominal wall below the diaphragm. Failure to drain a large hepatic wound is likely to result in fatal bile peritonitis. Bleeding from the liver may occasionally be controlled by applying a small piece of muscle held in place by a loosely tied suture.

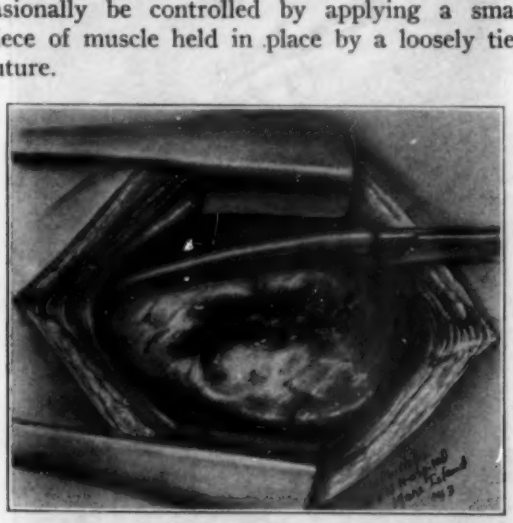

Fig. 11.—Localized mangling of a lung may require partial resection of the lobe (fig. 12).

On the left side a lacerated spleen may be removed through the diaphragmatic incision. Repair of a tear in the stomach or splenic flexure of the large bowel can also be effected through the diaphragmatic opening.

The rent in the diaphragm must be closed to avoid herniation of abdominal viscera into the chest, which is made imminent by the negative intrapleural pressure. A large wound in the left side of the diaphragm may permit herniation of the stomach, spleen or large bowel. Closure of the rent is easily effected when preceded by transpleural crushing of the phrenic nerve as it courses over the pericardium.

The defect in the thoracic wall producing the sucking wound must be closed, by approximation of muscle in layers if possible and of skin. To secure closure without tension it may be necessary to make semilunar incisions 5 to 6 cm. removed from the edge of the muscular defect, which will permit sliding of muscle over the defect (fig. 14). If muscle or subcutaneous tissue is not available for closure of the defect, it may be necessary to slide skin flaps over the defect by a single or by two semilunar incisions 6 to

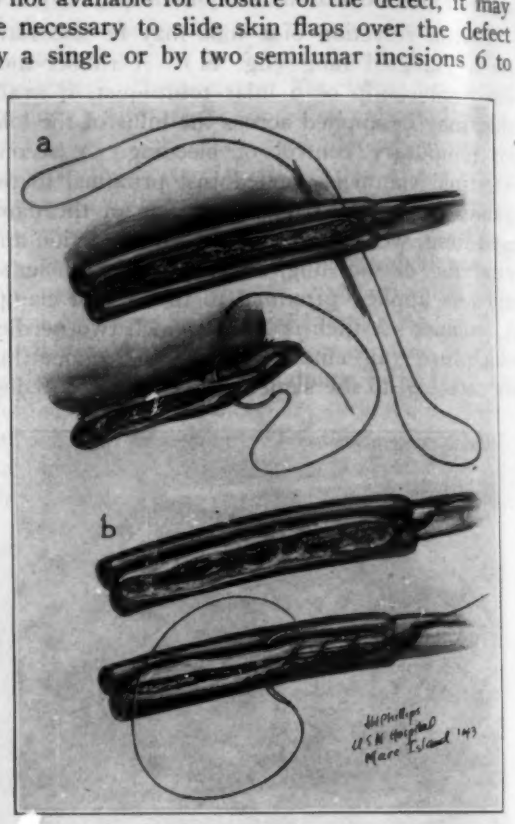

Fig. 12.—Two methods are available to close the cut surface of a lung after removal of traumatized tissue: (*a*) a continuous cobbler's stitch applied with two needles on the same thread reenforced with a continuous over and over stitch or (*b*) a continuous right-angled lock stitch applied to the cuff of the lung lying beyond the clamp. Doubly threaded atraumatic curved fine intestinal needles may be used instead of straight needles.

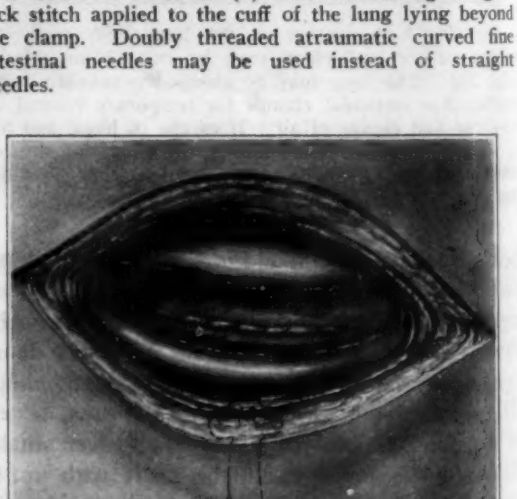

Fig. 13.—A mushroom-tipped catheter may be introduced into the thorax through an intercostal space independent of the incision for drainage following partial resection of the lobe or in the presence of gross contamination of the pleural cavity.

8 cm. removed from the defect. The raw surface on the thoracic wall thus produced may be subsequently epithelized by skin grafting. The essential immediate necessity is closure of the sucking wound, with whatever viable tissues are available. Occasionally, a lower thoracic defect is best closed by utilizing the diaphragm and stitching it to the parietal pleura above the defect. This is more easily done if the diaphragm is paralyzed by crushing the phrenic nerve transpleurally as it courses over the pericardium.

After any closure of a large wound of the thoracic wall or closure of an exploratory incision, early complete expansion of the lung is usually highly desirable. To insure proper intrathoracic conditions for immediate reexpansion, closure of the thoracotomy is followed immediately by shifting the patient to his back and performing an aspiration of intrapleural air, preferably in the second or third interspace anteriorly, with a closed controllable system. If positive pressure is present and sustained, indicating leakage of air from the lung, the needle should be left in place and escape under water provided until air ceases to flow out. Rarely is this necessary longer than twenty-four to thirty-six hours.

A slight negative pressure is desirable and may be easily achieved by removal of a moderate amount of air.

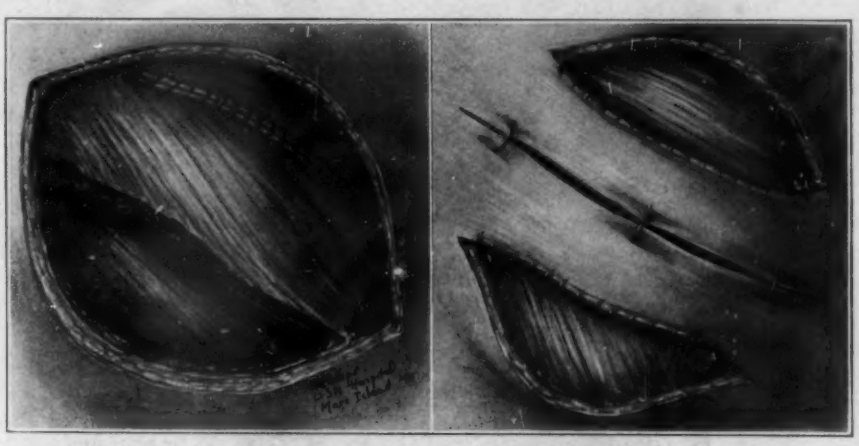

Fig. 14.—Closure of a sucking wound due to a defect in the thoracic wall may be effected by sliding muscle flaps which are mobilized by a semilunar incision either on one or on both sides, depending on tension necessary to approximate the edges over the defect. If muscle is unavailable, semilunar incisions in the skin also on one or both sides will permit closure of the defect. Subsequent epithelization of surface defects may be hastened by skin grafting.

8. FOREIGN BODIES IN THE LUNG

Clinical Considerations.—In general, foreign bodies more than 1 cm. in diameter should be removed, whereas small fragments which cause no symptoms need not be removed. Large, jagged sharp fragments may migrate, owing to their weight, reach the pleural surface and cause exquisite pain on deep breathing or on vigorous exercise. Moreover, a large foreign body known to the patient to be present is often a psychic hazard and may be held responsible in later life for symptoms originating elsewhere. Its mere presence may be an excuse for prolonged disability and justification for a pension. Hence the importance of removing large accessible foreign bodies, including those in the lung, when the hazard of operation is reduced to a minimum by ideal conditions for operation is obvious. Ideal conditions include facilities for accurate localization by fluoroscopy, availability of a fluoroscope in the operating room should it be necessary because of difficulty in locating the foreign body, an anesthetist trained and equipped to give closed anesthesia by the intratracheal route and a surgeon trained in thoracic surgery. Anesthesia administered by the intratracheal route permits expansion or collapse of the lung at will, and foreign bodies within the pulmonary substance are most easily felt with the lung collapsed. Moreover, a foreign body deep in the substance of the lung is most easily exposed with the lung collapsed. Two traction sutures are placed parallel to the proposed line of incision, and the lung is incised, no effort being made to control bleeding vessels or leaking bronchioles, except by digital pressure on each side of the incision. After removal of the foreign body, the cavity is gently curetted with a dull spoon or a curet to remove any clothing or other foreign material carried in with the metal fragment. A liberal amount of a powdered sulfonamide drug is placed in the cavity, and the rent in the lung is closed by first tying the retraction sutures and then applying a continuous right-

angled lock stitch, preferably of surgical gut, with an atraumatic needle. Deeply placed interrupted sutures of silk may also be used. Closure is tested by dropping water on the line of incision during expansion of the lung. If air escapes when the lung is fully expanded by the anesthetist, the intratracheal pressure is reduced to permit the lung to collapse to a point where escape of air no longer occurs, and the chest is closed with the lung in this partially collapsed state. When complete closure of the chest has been effected, the patient is placed on his back and an aspirating needle is introduced into the second interspace in the nipple line for the escape of air under pressure. Aspiration of air may again be necessary after two or three days.

A microscopic smear and culture of the coating on the foreign body should be made, for obtaining information which may be useful should complications subsequently occur.

9. THORACOTOMY FOR EXPLORATION OF THE ANTERIOR MIDDLE PORTION OF THE CHEST

Practical Exercise.—Thoracotomy incisions are made and repaired, employing intercostal incisions without resection of a rib but with fracture of the sternal or vertebral end of the adjacent ribs to permit greater exposure. The removal of long segments of one or two ribs is no longer considered necessary.

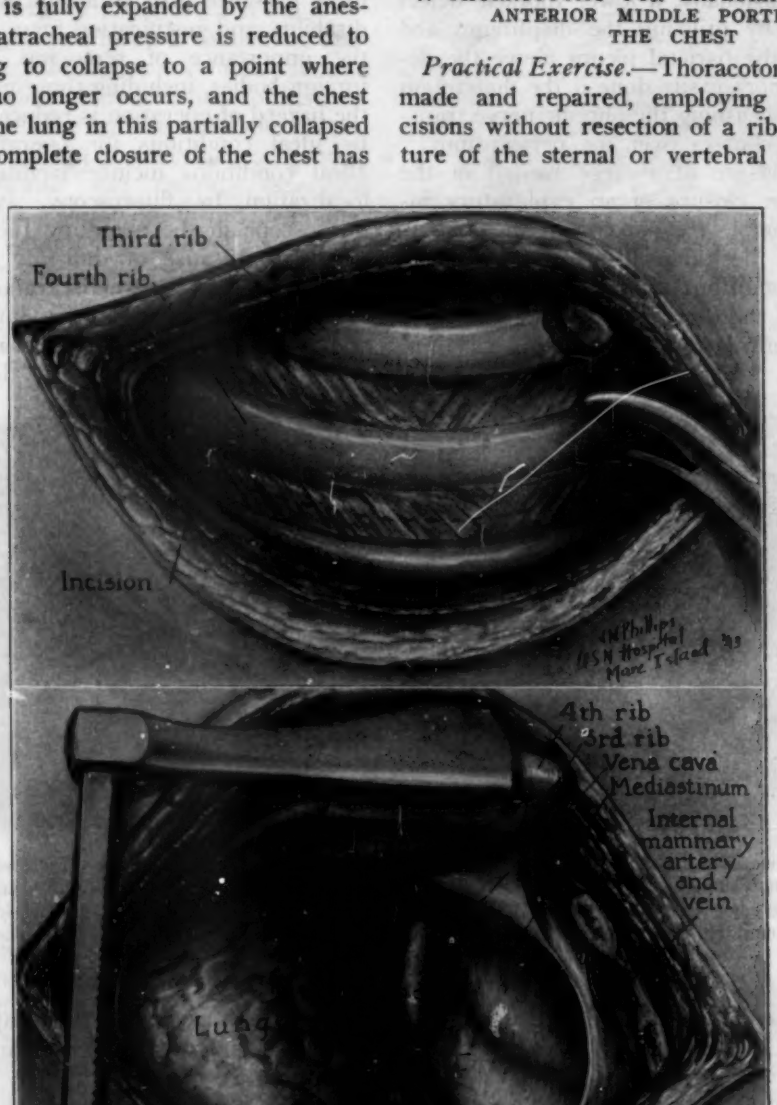

Fig 15.—Exposure of the anterior middle portion of the chest: An incision is made in the skin paralleling the fourth interspace and running laterally from the sternal border. The costochondral junction is divided by removal with a rongeur of the cartilages of the denuded third and fourth ribs. The hilus is exposed by a screw retractor.

Clinical Considerations.—For exposure of the hilus and the midportion of the chest, an antero-

lateral incision in the fourth interspace is made, dividing the skin, pectoral muscle, intercostal musculature and pleura. If the screw type of self-retaining retractor is available, the ribs can usually be separated sufficiently for exploration of the thoracic cavity. If further exposure is necessary, the costal cartilages of the fourth and third ribs are divided and the ribs displaced upward by the self retaining retractor (fig. 15).

Closure of the Chest (fig. 16): The fourth and fifth ribs are drawn as closely together as possible by three or four circumcostal sutures of doubled no. 2 chromic catgut or stainless steel wire, which are applied above the fourth and below the fifth rib; the neurovascular bundle is avoided in each instance by keeping the sutures close to the rib. The upper edge of the divided pectoral muscle and the inferior edge of the divided intercostal musculature are approximated with interrupted sutures of silk (or cotton); the inferior edge of the divided pectoral muscle and the outer surface of the superior flap of the divided pectoral muscle are approximated by interrupted sutures of silk, which thus overlap the first row of sutures. The subcutaneous tissues are drawn together with interrupted silk sutures and the skin with a continuous suture of fine steel wire. Steel wire produces less foreign body reaction and inflammation in the skin than any other suture material.

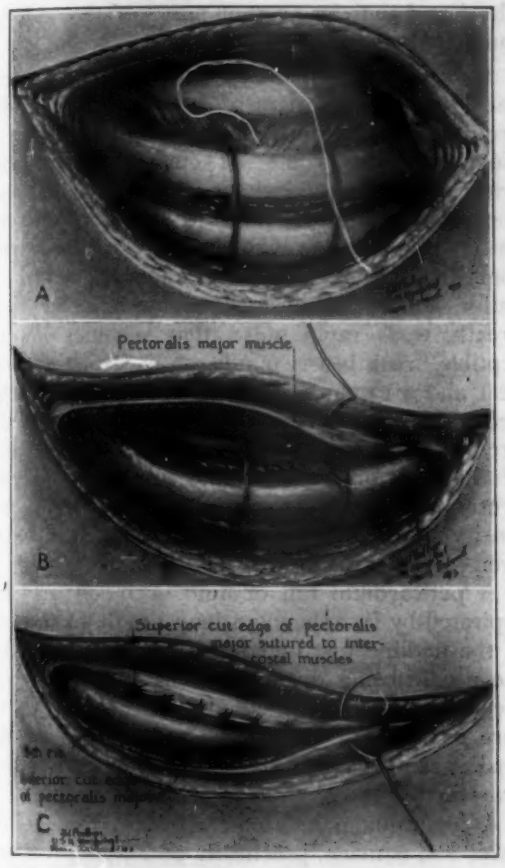

Fig. 16.—Closure of the anterior incision: (*a*) pericostal sutures of either doubled no. 2 chromic catgut or fine steel wire; (*b*) approximation of the superior edge of the divided pectoralis muscle to the inferior cut edge of the divided intercostal musculature by interrupted sutures of silk; (*c*) approximation of the inferior edge of the divided pectoralis muscle to the outer surface of the upper edge of the pectoralis muscle by interrupted silk sutures. A continuous steel suture approximates the cutaneous edges.

No drainage is indicated in the ordinary thoracotomy. If drainage is indicated, as in mangled or lacerated lung requiring suture or in gross contamination from dirt and foreign material, it should not be done through a thoracotomy wound. A mushroom-tipped catheter is introduced in the first intact intercostal space either above or below the incision (before closure of the chest) and is attached to a long rubber tube, which is placed under water for air-tight drainage (fig. 13).

Fig. 17.—Patient J. H. as seen on Jan. 19, 1944. For exposure of the lower half of the chest and diaphragm, a posterolateral incision in the eighth interspace is used. For moderate exposure, as was used for the removal of a bullet from the lower lobe of this patient, the ribs need not be divided but can be adequately spread by the screw type of rib spreader. When greater exposure is necessary the eighth and seventh ribs are divided posteriorly underneath the erector spinae muscles, which are displaced medially. For closure the edges of the divided latissimus dorsi muscle are used as were the edges of the pectoral muscle anteriorly (fig. 16).

10. THORACOTOMY FOR THE EXPOSURE OF THE LOWER PORTION OF THE CHEST AND DIAPHRAGM

Clinical Considerations.—Exposure of the lower portion of the chest and diaphragm by

thoracotomy is usually performed in the eighth interspace in the posterolateral area (fig. 17). For limited exposure, as for the removal of foreign bodies which are easily accessible, the ribs need not be divided but can be spread sufficiently with a screw type of rib spreader. If more exposure is needed, the eighth and ninth ribs can be divided subperiosteally just lateral to the transverse processes underneath the erector spinae muscle. These muscles should not be divided but elevated, as they may be useful later in obtaining air-tight closure of the posterior extremity of the incision. The ribs are denuded of their periosteum for about 1.5 cm., and this denuded portion of the ribs is excised, to prevent subsequent pain from motion at the site of division of the rib. Additional exposure through this incision may be obtained by superiosteal division of the seventh rib at the same level. Closure of the wound in this area is affected by three circumcostal sutures of no. 2 chromic catgut doubled or of fine steel wire with approximation of the eighth and ninth ribs. The upper edge of the divided latissimus dorsi muscle is sutured to the inferior edge of the divided intercostal musculature with interrupted sutures of silk, and the lower edge of the latissimus dorsi muscle is sutured to the surface of this muscle above the wound; hence this second row of sutures overlaps the first line of sutures. Subcutaneous sutures of silk and a continuous suture of silk or steel in the skin complete the closure.

11. WOUNDS OF THE HEART (AFTER BECK)

Practical Exercise.—The heart of an anesthetized animal is exposed through an intercostal incision in the left upper portion of the chest. A catheter may be introduced into the pericardial sac and saline solution allowed to flow into the sac under controlled pressure to illustrate the effect of cardiac tamponade. The saline solution is withdrawn, and with an ice pick or a sharp scalpel a stab wound of the heart is produced, the pericardium is allowed to fill with blood until perceptible beating of the heart has ceased, the pericardium is opened, the confined blood is evacuated and the heart is massaged in a rhythmic manner if it is momentarily in asystole. The wound in the heart is sought for and the bleeding point controlled by digital pressure if it is in the ventricle. A rent in the auricle cannot be controlled by pressure but must be closed by grasping each edge separately with hemostats, drawing them together and approximating the edges with interrupted fine silk sutures. A traction suture of silk is applied to the apex of the heart for manipulation and steadying of the heart and for exposure of the posterior surface, should the wound involve that surface. With traction on the apical suture and the wound in the heart still closed by digital pressure, sutures of silk on fine needles are applied on each side of the finger compressing the wound. The finger is withdrawn, and the sutures are crossed and held taut, while additional interrupted silk sutures are applied to the lips of the wound. Sutures must be applied parallel to and not across visible branches of the coronary artery. After complete control of bleeding is obtained, the apical suture is withdrawn and the pericardium incompletely closed with two or three interrupted widely spaced sutures, to permit escape of pericardial fluid or blood and thereby prevent postoperative cardiac tamponade.

Clinical Considerations.—Increased intrapericardial pressure, namely, cardiac tamponade, requires prompt relief to avoid death. When a single thoracic wound of entrance is present without a wound of exit or when the heart and the pericardium lie in the path of a through and through penetrating wound, the following symptoms should suggest cardiac tamponade: extreme pallor and/or cyanosis, extreme shortness of breath, weak rapid pulse, that becomes imperceptible, weak heart sounds, absence of the apex beat and a gradually decreasing blood pressure, decreasing pulse pressure and increasing venous pressure, as disclosed by distention of the veins of the neck or by actual measurement. These presenting symptoms may vary greatly in intensity and in rapidity of development, and some even may be absent until just before death.

A pericardium full of fluid or blood may be aspirated by introducing a long needle to the left of the midline just under the left costal margin, the needle being directed toward the middle of the left clavicle. If methods for relieving pressure or obtaining blood are unsuccessful when cardiac tamponade is suspected, exposure of the heart is necessary.

A longitudinal incision slightly curved at its lower end is made, practically paralleling the left sternal border and permitting excision of the fifth costal cartilage, the fourth costal cartilage, part of the fourth rib and the third costal cartilage. Division of the triangularis sterni muscle and deflection of the left pleura laterally reveal the pericardium. The wound already present is extended or the pericardium is incised longitudinally between two stay sutures of silk. The blood clots are emptied out, and the procedures as described in the preceding experiment, with closure of the bleeding wound, are carried out.

After loose closure of the pericardium, the left pleura is opened so that any pericardial fluid or blood may leak into the left pleural cavity, where it may more readily be absorbed or from which it may easily be aspirated if necessary.

No drainage with a rubber tube or a tissue drain is indicated except in the presence of gross pus. When aspiration of the pericardium, as described previously, has revealed the presence of pus, the incision is greatly limited, and excision of one costal cartilage at the level of the sixth rib anteriorly is sufficient.

12. GUNSHOT WOUNDS OF THE CHEST

Practical Exercise.—The final exercise consists in placing an anesthetized animal upright against some heavy sand bags and shooting it through the chest with a revolver at a distance of about 5 feet (1.5 meters). The damage inflicted is then repaired according to the principles laid down in the previous exercises.

The animal is always killed at the end of the exercise, but it is surprising how often complete repair of the wounded organs is possible, and it is probable that in many of these instances the dog would survive if it were allowed to.

PARALYSIS OF THE LARYNX

AN EARLY SIGN OF RECURRENCE FOLLOWING RADICAL MASTECTOMY FOR CARCINOMA, WITH A REPORT OF SIX CASES

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In this era of surgical treatment of cancer it is not necessary to reemphasize the importance of early recognition of the disease. This applies not only to the initial diagnosis but to the postoperative follow-up visits, when the patient is carefully examined for evidence of a recurring lesion. The following 6 cases of surgically treated cancer of the breast point out a helpful clinical observation to aid in the early recognition of recurrence.

When hoarseness occurs following mastectomy for carcinoma of the breast the possibility of metastasis must be considered. In each of the cases presented in this group there was a period following mastectomy during which the patient enjoyed complete symptomatic freedom from disease. This period varied from fourteen months to twelve years. The patient's well-being was then suddenly interrupted by changes in the voice, described as persistent hoarseness or huskiness. There were also intermittent weakness of the voice, a tendency for the voice to crack and a nonproductive cough, unaccompanied by any evidence of infection of the respiratory tract. Dyspnea was severe in 1 patient and was experienced on exertion by the others. In each instance, however, it was the laryngeal disturbance which caused the patient to consult her physician.

With curiosity directed toward the larynx, an effort was promptly made to determine the cause of the hoarseness. The most important diagnostic procedure was inspection of the larynx. This was accomplished by indirect, or mirror, laryngoscopy, a relatively simple procedure, which requires a laryngeal mirror and an adequate source of illumination. Visualization of the larynx revealed the cause for the hoarseness to be fixation of one or both vocal cords. This failure of movement of a vocal cord accompanied by loss of tension or relaxation characterized the paralysis of the recurrent laryngeal nerve on the affected side. In seeking the reason why a recurrent laryngeal nerve should suddenly cease to function in these cases one is struck by the importance of metastatic recurrence of mammary cancer.

Part of the drainage of lymph from the breast has been satisfactorily traced to the chain of nodes surrounding the recurrent laryngeal nerve. Metastasis, therefore, may be from a cancerous breast on the same or on the opposite side. The three generally accepted lymphatic pathways of homolateral drainage are [1]:

1. From the mamma to the axillary nodes, to the supraclavicular group and to the thorax via the chain of nodes surrounding the recurrent laryngeal nerve.

2. From the mamma directly to the subclavian nodes and to the infraclavicular plexus. This plexus empties into the junction of the internal jugular and subclavian veins but gives off some efferent vessels to the supraclavicular nodes, which in turn are linked to the chain of nodes around the recurrent laryngeal nerve.

3. From the mamma, perforating the pectoralis major, pectoralis minor and intercostal muscles, to the internal mammary chain. This pathway terminates in the venous circulation at the root of the neck. Some aberrant efferent vessels pass over the clavicle and drain directly into the supraclavicular nodes and thence proceed to the chain in the region of the recurrent laryngeal nerve.

Contralateral involvement, interestingly, is not the exception, since it occurs with almost the same frequency as paralysis of the same side.[2] Contralateral spread occurs from the cutaneous lymphatics overlying the periphery of the mammary structure and from the lymphatics near the inner periphery of the mamma. Both of these pathways terminate in the axillary and supraclavicular groups of nodes of the opposite side. From these routes it may be concluded that the most likely seat of metastasis is in the supra-

From the Department of Laryngology, Jefferson Medical College Hospital.

1. Turner, A. L.: Paralysis of the Vocal Cords Secondary to Malignant Tumor of the Mamma, J. Laryng. & Otol. **36**:373, 1921.

2. Turner, A. L.: Abductor Paralysis of the Right Vocal Cord Subsequent to Scirrhous Cancer of the Left Mamma, J. Laryng. & Otol. **40**:534, 1925.

clavicular and/or the internal mammary group. Since both these groups drain into the lymph nodes surrounding the recurrent laryngeal nerve, paralysis of a vocal cord gives early warning that all is not well.

The following 6 case histories are from the department of laryngology of the Jefferson Medical College Hospital.

REPORT OF CASES

CASE 1.—E. M., a 41 year old white woman, was well for eighteen months following radical mastectomy for carcinoma of the right breast. The patient suddenly acquired hoarseness, followed by a nonproductive cough. There was no dyspnea; but a constant feeling of fatigue, with a loss of 10 pounds (4.5 Kg.) in two months, was described. Laryngeal examination revealed left-sided paralysis with the vocal cord in the cadaveric position. The tension was poor. The right side of the larynx showed no changes. Roentgen study of the chest revealed a dense shadow at the root of the left lung.

The diagnosis was paralysis of the left recurrent nerve and metastatic carcinoma of the hilar area of the left lung.

CASE 2.—B. W., a 45 year old white woman, remained free of symptoms for two years following radical mastectomy for carcinoma of the right breast. A tired feeling in the throat with progressive weakening of the voice began two weeks before hoarseness developed. When changes in the voice did not improve, the patient presented herself for examination, six weeks after the onset. The larynx showed complete paralysis of the left side with the left vocal cord in the cadaveric position. The right side of the larynx was normal. A firm mass was palpable in the left supraclavicular area. Endoscopic examination of the larynx and hypopharynx did not yield any additional information. Roentgen study of the chest failed to reveal any metastasis.

The diagnosis was paralysis of the left recurrent nerve and metastatic carcinoma of the supraclavicular cervical lymph nodes.

CASE 3.—T. S., a 44 year old white woman, had a radical mastectomy of the left breast for scirrhous adenocarcinoma. After twelve years of good health the patient suddenly began to suffer from hoarseness with some dyspnea, notably on exertion, and examination of the larynx revealed bilateral paralysis of the larynx with both vocal cords in the midline. Three days after the onset of dyspnea, it was necessary to do a tracheotomy. The patient died of respiratory embarrassment two days later. Postmortem examination revealed metastatic scirrhous adenocarcinoma of the mediastinal structures, lymph nodes and great vessels of the neck and lungs and also metastatic carcinoma of the lateral nucleus of the thalamus. Severe compression of the trachea below the site of the tracheotomy tube was present.

The diagnosis was paralysis of the recurrent laryngeal nerve of both vocal cords and metastatic scirrhous adenocarcinoma of the mediastinum and the lateral nucleus of the thalamus.

CASE 4.—C. R., a 47 year old white woman, submitted to radical mastectomy of the right breast for scirrhous adenocarcinoma. Fourteen months later she suddenly noticed hoarseness and a nonproductive cough. One month later, when changes in the voice persisted, she presented herself for examination. Laryngeal examination revealed the left vocal cord fixed in the midline with good tension. No other laryngeal changes were present. One month later paralysis of the left cervical sympathetic nerves occurred, resulting in Horner's syndrome. The left vocal cord then had assumed the cadaveric position. A firm, nontender mass was palpable in the left supraclavicular area.

The diagnosis was paralysis of the left recurrent laryngeal nerve and metastatic carcinoma of the cervical lymph nodes.

CASE 5.—F. P., a 42 year old white woman, underwent radical mastectomy for adenocarcinoma of the right breast. Two years and three months later hoarseness suddenly developed, with no accompanying evidence of an infection of the respiratory tract. A hard, nontender mass was palpable in the right supraclavicular area. The larynx showed fixation of the right vocal cord in the midline with good tension. There was some difficulty in swallowing. Biopsy of the lymph nodes which were adherent to the right carotid sheath and involved the right recurrent laryngeal nerve revealed metastatic adenocarcinoma. Three weeks after biopsy the larynx had not shown any improvement.

The diagnosis was paralysis of the right recurrent laryngeal nerve and metastatic carcinoma of the cervical lymph nodes.

CASE 6.—M. C., a 55 year old white woman, had a radical mastectomy for adenocarcinoma of the left breast. After two years of good health the patient suddenly became hoarse. Examination of the larynx revealed complete paralysis of the left side of the larynx with the left vocal cord in the cadaveric position. Subsequently supraclavicular lymphadenopathy on the left side and Horner's syndrome developed. She died of carcinomatosis six months later.

The diagnosis was paralysis of the left recurrent laryngeal nerve and carcinomatosis.

SUMMARY

Hoarseness occurring after radical mastectomy for carcinoma of the breast is often the first clinical evidence of metastasis.

Metastasis from carcinoma of the breast causes paralysis of the recurrent laryngeal nerve on the same or on the opposite side by involving the chain of lymph nodes surrounding the recurrent laryngeal nerve.

COMPLETE RUPTURE OF THE SUPRASPINATUS TENDON

A SIMPLIFIED OPERATIVE REPAIR

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Complete rupture of the supraspinatus tendon is not only a relatively common lesion but an extremely painful one. In spite of this, the diagnosis is seldom made and the condition suffers from general neglect. Several instances will be cited in proof of this statement. In May 1943, a study was made of the records of a fine orthopedic clinic. These records covered fifteen years, and in them were listed six hundred and fifty varied types of painful shoulders. The diagnosis of complete rupture of the supraspinatus tendon was not made in a single case. This finding aroused great curiosity, and as a result personal conversations were held with twenty leading orthopedic surgeons in the middle and far west in the eight months that followed. Without a single exception, they readily admitted never having made the diagnosis of complete rupture, and consequently they had never seen or repaired such a rupture. In contrast, in the clinical material that is the basis of this report 3 cases of complete rupture of the supraspinatus tendon were found in a series of only 51 cases of painful shoulder.

The present status of complete rupture of the supraspinatus tendon cannot be accurately evaluated without atempting to correlate several conflicting factors. The startling frequency of this condition can be recognized by noting various postmortem studies on the shoulder joint, including those made by Meyer, Codman and Akerson and by Keyes, and the latest, made by Wilson and Duff. As two of these (Codman and Akerson [1] and Wilson and Duff [2]) were in practically complete agreement as regards incidence of lesions, the findings in these studies will be combined and reviewed.

The article by Wilson and Duff was written in somewhat greater detail than that by Codman and Akerson. The combined findings showed that after the 30 year age limit between 30 and 40 per cent of 225 unselected bodies had demonstrable lesions in the supraspinatus tendon. In one-half the bodies, or 15 to 20 per cent of all shoulders, the lesion was large (complete rupture). With large scale rupture there are often two accompanying lesions: one, loss of hyaline cartilage from the humeral head; the other, tendinitis or concomitant rupture of the tendon of the long head of the biceps muscle. Both articles agreed that the latter lesion is never found without accompanying rupture. Degenerative lesions become more frequent and severe with advancing years. In the second article it was mentioned that differential stains demonstrated degenerative changes in the supraspinatus tendon, which antedate and predispose to subsequent rupture.

Personal experience may shed light on this discrepancy, namely, clinical lack of recognition as opposed to an amazing frequency observed post mortem. Only recently has it been realized that all too frequently this condition has bizarre symptoms which do not correspond in any way to the classic postulates for diagnosis laid down by Codman. Other observers have also noted this. Prior to five years ago, in most cases the correct diagnosis was not even suspected. It was finally realized that any chronic monarticular painful shoulder should be explored if it failed to respond to prolonged conservative treatment. Even this did not solve the problem. At first, the investigation was made through the inadequate anterior or lateral muscle-splitting incision, recommended by Codman and others. Owing to the invariable presence of dense bursal adhesions, neither of these incisions permits adequate investigation of the anterior, middle and posterior compartments. The incision now used for exploration has initiated proper recognition of the pathologic process, and it will be described in considerable detail, with the operative technic used in case 1.

As a result of these articles and a variety of clinical experiences, an attempt should be made to reconcile these postmortem observations with pathologic and clinical concepts as they concern

From the Orthopedic Service, Cedars of Lebanon Hospital, Los Angeles.

1. Codman, E. A., and Akerson, I. B.: The Pathology Associated with Rupture of the Supraspinatus Tendon, Ann. Surg. **93**:348 (Jan.) 1931.

2. Wilson, C. L., and Duff, G. L.: Pathologic Study of Degeneration and Rupture of the Supraspinatus Tendon, Arch. Surg. **47**:135 (Aug.) 1943.

rupture of the supraspinatus tendon. With advancing years, degenerative changes occur in connective tissue, just as they do in other tissues. But, owing to the focal action of certain components of force, as shown in the accompanying illustration (fig. 1), they are present in aggravated form at the central portion of the supra-

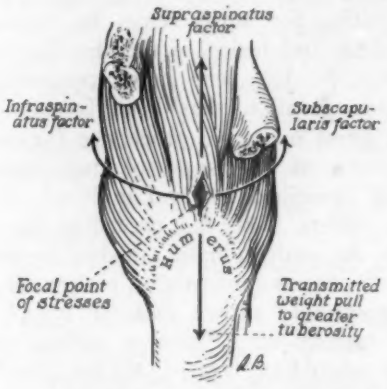

Fig. 1.—Diagram illustrating the two horizontal and the two vertical components of force. By continuous action on this focal point they combine to keep the capsulotendinous sheet taut at this point. This tends to cause degenerative lesions, which in turn lead to varying degrees of rupture. To the humerus factor must be added the weight supported by the hand and forearm.

spinatus tendon just above its point of final attachment to the horizontal line of the greater tuberosity of the humerus. The presence of this weakened area predisposes the tendon to small rupture when it is subjected to slight trauma and to large scale rupture when greater forces are applied. Once rupture occurs, there is retraction of the edges, owing to the pull of these four components of force. It can also be demonstrated on the operative table that dependency of the arm aids in keeping the rent open. Physiologically ineffectual attempts to repair this defect result in a piling up of connective tissue. This is aggravated, and complete healing is blocked by movements of the shoulder joint. In this scar tissue and in the defect, there is often a deposition of calcium. This represents an abortive frustrated attempt at healing. As a result, throughout the entire adjoining area there is chronic inflammatory reaction. The lateral surface of the lesion is the subacromial bursa and is an integral part of this zone. Therefore, this particular portion is chronically inflamed and becomes technically the seat of subacromial bursitis (fig. 2*B*). It could just as correctly be termed periarthritis.

In large scale rupture, there are other factors. The loss of the central capsular support must cause a certain amount of sagging of the head of the humerus. This should transmit increased weight to the tendon of the long head of the biceps muscle, the sole central survivor. This overstrain causes chronic inflammation (tendinitis), which in time results in a fraying or flattening of the tendon. The end result is rupture, which, as has been mentioned, is always coupled with tears of the supraspinatus tendon. Long-continued chronic inflammatory reaction about the large rent inevitably leads to loss of bordering cartilage from the articular surface of the head of the humerus. This is arthritis. This sequence of pathologic events has led to the current clinical ideas on which are based the diagnosis and the treatment of varying types of rupture of the supraspinatus tendon (fig. 2*B*).

It is well recognized that the late Dr. E. A. Codman [3] gave the first significant description of both small and large scale rupture of the supraspinatus tendon. Careful study of this monograph would seem to indicate that he observed less than a dozen cases of complete rupture, whereas in the same volume he listed hundreds of cases of incomplete rupture. These clinical statistics do not correspond in any particular with his postmortem studies, which revealed large scale rupture and small scale rupture with approximately equal frequency. He noted that in the presence of complete rupture the patient found it impossible to abduct the arm.

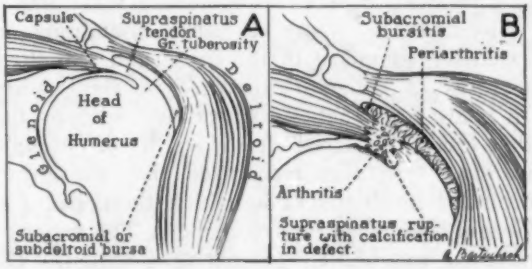

Fig. 2.—*A*, diagrammatic cross section illustrating the anatomic interrelation between the head of the humerus, supraspinatus muscle, supraspinatus tendon, capsule, subacromial bursa and deltoid muscle. The tendons of the capsular muscles fuse with the capsule just before final bony insertion to form a conjoined tendon (musculotendinous cuff). It is in this structure that the varying types of rupture occur. *B*, illustration indicating the lesions that follow and complicate rupture of the tendon. Abnormal calcification, subacromial bursitis, periarthritis, arthritis and bicipital tendinitis are usually not clinical entities but sequelae.

From this observation, it was theorized that the normal function of the supraspinatus muscle is to stabilize the head of the humerus in the glenoid cavity so that the deltoid muscle may exert its full force of leverage against a firm

3. Codman, E. A.: The Shoulder, Boston, The Author, 1934, p. 156.

base. Later, Watson-Jones supported and illustrated this.[4] This has given rise to what is known as the deltoid-supraspinatus synergistic theory. All previous operative procedures, with the exception of those of Bosworth and McLaughlin, have been based on this hypothesis and the belief that the supraspinatus muscle must be recovered and restored to its normal position if any degree of normal function of the shoulder is to be obtained.

Codman also was the first to describe an operation for the repair of complete rupture. He recommended that the tendon be exposed by means of the "saber cut" incision, this being a transverse incision over the upper surface of the shoulder. The acromioclavicular joint is severed, the acromion process is cut through and reflected and the tendon is recovered and sutured with silk. In this portion of his monograph, the subject matter is most confusing. In one place he mentioned "the saber cut which gives a perfect exposure," and a few pages later he stated that "this incision has been given up as certain cases developed instability of the joint following operation." He was far from satisfied with the end results in these cases, and, on page 261, he stated: "On the whole the outcome of cases with complete rupture is relatively poor." He expressed the opinion that this was due to the fact that the patients were seen later.

The next reparative operation was that of Wilson.[5] He wrote a paper containing an extensive summary of the cause and pathologic features of complete ruptures of this nature. In it are many acute observations, such as that the lesion occurred from slight or minimal trauma. He also recognized that the injury occurred in shoulders in which there had previously been degenerative changes. The exposure he used was similar to that of Codman. The tendon was pulled down and by means of a fascia lata suture was inserted into a bony trough on the lateral surface of the upper end of the humerus. Ten cases in all were reported, with apparently excellent end results.

The next operative modification was reported by Mayer.[6] This at first was similar to the one described by Wilson, but after 3 cases he noted, as a result of the splitting of the deltoid muscle, development of severe weakness of the anterior fibers of this muscle. He stated the belief that this was due to injury to the anterior branches of the axillary nerve. In his last case he used the incision to be described subsequently. He further advised immobilization of the arm in abduction after operation.

Another procedure was recommended by Bosworth.[7] In addition to giving an excellent classification for small rents, he recommended arthrodesis and fusion of the shoulder for large rupture. As has been noted previously, none of these operations has been frequently used.

The latest operative procedure for correction of rupture of the supraspinatus tendon was recently described by McLaughlin.[8] His procedure differs from the preceding in that, although the supraspinatus tendon is recovered, he places strong emphasis on restoration of capsular continuity rather than on complete anatomic reposition. From a series of 3,000 painful shoulders treated at the Presbyterian Hospital in New York in the past ten years, he found 32 complete ruptures and 8 massive avulsions. His method of exposure is similar to that of Codman, but the reparative procedure differs from others in that the lesion is closed from side to side instead of from end to end and the various edges are fastered to the lateral surface of the humerus by means of drill holes and sutures. His reported end results were good.

In 3 cases complete rupture of the supraspinatus tendon was repaired by an operative procedure which differs radically from any that have been previously described. Because of this, it will be necessary to describe the rationale that led to these changes. In previous articles, attention has been called to the fact that the head of the humerus may be resected when made necessary by irreducible fracture dislocation or severe comminution of the head of the humerus. If the capsule attached to the head is discarded, the condition known as "flail shoulder" results in almost 50 per cent of the cases. If, however, the capsule is reattached to the outer upper end of the shaft by means of bony grooves, a stable shoulder is the invariable result. When these grooves are arranged to follow the physiologic pattern, stability is accompanied by almost complete functional recovery. This is a practical demonstration that the capsule of the shoulder joint as it attaches

4. Watson-Jones, R.: Injuries in the Region of the Shoulder Joint: Capsule and Tendon Injuries, Brit. M. J. **2**:29 (July 2) 1938; Fractures and Other Bone and Joint Injuries, Baltimore, Williams & Wilkins Company, 1940.

5. Wilson, P. D.: Complete Rupture of the Supraspinatus Tendon, J. A. M. A. **96**:433 (Feb. 7) 1931.

6. Mayer, L.: Rupture of the Supraspinatus Tendon, J. Bone & Joint Surg. **19**:640 (July) 1937.

7. Bosworth, D.: Supraspinatus Syndrome: Symptomatology, Pathology and Repair, J. A. M. A. **117**: 422 (Aug. 9) 1941.

8. McLaughlin, H. L.: Lesions of the Musculotendinous Cuff of the Shoulder: I. The Exposure and Treatment of Tears with Retraction, J. Bone & Joint Surg. **26**:31 (Jan.) 1944.

to the upper end of the humerus represents a dual structure, the capsule and the fused tendons of the "short rotator" muscles. It was only a short step to speculate that if function could be restored in the face of great anatomic defects it should be relatively simple where the defect is much less.

Before proceeding to detail certain physiologic observations that led to the changed operative procedure, it will be necessary to review certain key points of the surgical anatomy of the shoulder joint. Should a more detailed and illustrated description be desired, it can be found in a preceding article.[9]

The "short rotator" or capsular muscles, for this purpose, are considered as three, rather than four. Proceeding backward these are: the subcapsularis, the supraspinatus and the infraspinatus teres minor muscle. All of these fuse with the capsule of the shoulder joint before final bony insertion to form a conjoined tendon (fig. 2*A*). This structure has been given a special name, "the musculotendinous cuff" (Codman). The supraspinatus and infraspinatus teres minor muscles arise from the posterior surface of the scapula and at this point are separated by the spine (base) of the acromion process. In their outer half, they fuse to become a continuous musculotendinous sheet under the recess of the projecting acromion process. The fibers of the supraspinatus muscle insert into the transverse line of the greater tuberosity, while the fibers of the infraspinatus teres minor muscle insert into the posterior descending line. The subscapularis muscle arises from the anterior surface of the scapula, and the tendon winds anteriorly to insert into the lesser tuberosity of the humerus and a line which can best be defined as the anterior border of the bicipital groove. By fascial prolongation, they finally insert into the anterior descending line of the greater tuberosity. The continuous line of the greater tuberosity, because of its shape (an inverted U), has been termed the "horse shoe." These key points of surgical anatomy should be borne in mind, as only the lower edges of these structures can be seen after reflection of a flap of deltoid muscle and in the presence of an intact bony acromioclavicular arch. Further, they differentiate right and left (fig. 1).

Mention has already been made of the physiologic concept that governed previous operative procedures. The simplified operative repair is based on an altered idea as to the function of the capsular muscles.

The reconstructive operation that was mentioned affords sufficient evidence to support the contention that the major function of the capsular or "short rotator" muscles, acting as a group, is to stabilize the head of the humerus in the glenoid cavity. In short, working together they constitute the real antagonist for the deltoid muscle. In support of this hypothesis, it has been noted that the combined weight of the groups is approximately the same as that of the deltoid muscle. Further, they lie under and approximate the shape of the deltoid muscle to such an extent that Codman once spoke of them as the "inner deltoid."[10]

Attention has been called to the fact that the supraspinatus muscle is small when compared with its neighbors, the subscapularis muscle in front and the infraspinatus teres minor muscle in back. When these three muscles are completely excised and weighed, the supraspinatus muscle weighs only one seventh of the total. The relatively small size of the supraspinatus muscle has been confirmed in a recent article, in which it was stated that it weighed only a little more than one twentieth as much as the total scapulohumeral musculature.[11] Because of the small size of the supraspinatus muscle, it seemed reasonable to surmise that the complete loss of abduction which frequently followed complete rupture could not be due to the loss of the supraspinatus muscle alone. A muscle weighing 65 Gm. could not be the sole antagonist for the deltoid muscle, which weighs seven times as much. Anatomic dissections also had revealed that these powerful muscles in front and in back pull not only against their bony insertion but against each other through the central link of the conjoined tendon (musculotendinous cuff). This is the tendon of the supraspinatus muscle. Consideration of these facts led to the conclusion that the very presence of this central rupture produced inaction of the neighboring muscles, the subscapularis muscle in front and the infraspinatus teres minor muscle in back. Each of these muscles weighs three times as much as the supraspinatus muscle.

From the preceding anatomic and physiologic observations, it seemed feasible that a flap be borrowed from the contiguous visible upper portion of the infraspinatus muscle and transplanted as a substitute for the ruptured and retracted tendon of the supraspinatus muscle. Then, by suturing the edges of this transplant to the muscles in front

9. Jones, L.: The Shoulder Joint: Observations on the Anatomy and Physiology, Surg., Gynec. & Obst. **75**:433 (Oct.) 1942.

10. Codman, E. A.: Personal communication to the author.

11. Inman, V. T.; Saunders, J. B. deC. M., and Abbott, L. C.: Observations on the Function of the Shoulder Joint, J. Bone & Joint Surg. **26**:1 (Jan.) 1944.

and in back capsular continuity would be reestablished. This theory of restoration of capsular continuity, however accomplished, has recently been given powerful support by McLaughlin, although his method of operative repair differs radically.

Where the defect was large, with the rent extending into the neighboring muscles, as in complete avulsion of the upper capsular segment,

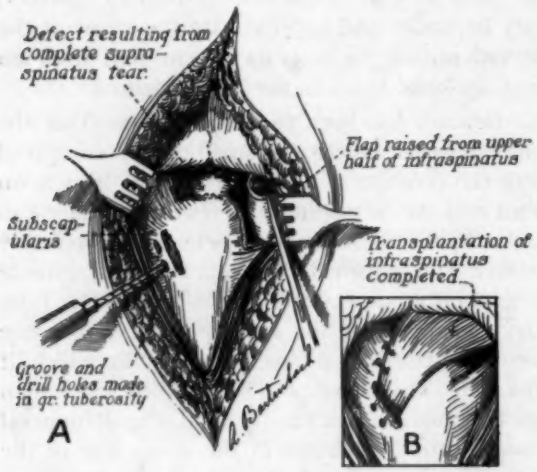
Defect resulting from complete supra-spinatus tear.
Flap raised from upper half of infraspinatus
Subscap-ularis
Transplantation of infraspinatus completed.
Groove and drill holes made in gr. tuberosity
A
B

Fig. 3.—*A*, diagram illustrating simple complete rupture of the supraspinatus muscle of the left shoulder, with retraction of the tendon. A flap from the upper portion of the visible infraspinatus muscle is substituted for the retracted supraspinatus muscle and swung into a bony groove with entrant drill holes. *B*, diagram illustrating complete transplantation and linking of the flap to the muscles in front and back, thus reestablishing capsular continuity. Fixation was obtained with silk sutures, although fascia sutures are preferable.

two flaps were borrowed, one from the infraspinatus and the other from the subscapularis muscle. A small amount of muscle power is lost by failure to recover the supraspinatus muscle. Avoidance of the difficulties and postoperative complications attendant on its recovery compensates for this. Further, additional purchase (muscle power) is obtained by inserting the transplant farther down on the shaft of the humerus. Certain diagnostic and surgical information can best be conveyed by a study of the following case reports.

REPORT OF CASES

Case 1.—Mrs. T. J., a housewife aged 26, was first seen on Dec. 5, 1941. Her chief complaint was pain in the left shoulder of over seven years' duration. The past history revealed that seven years before this date she was thrown from a truck. Immediately thereafter she noted pain in the left shoulder, and this persisted with only slight variation up to the time when she was first seen by me. The patient was examined by four different orthopedic specialists and one group of orthopedists during this period. All made diagnoses of subacromial bursitis and treated her conservatively. One irrigated the bursa under local anesthesia for one and one-half years. Another recommended application of a plaster spica, to be followed by physical therapy. Her latest treatment consisted of the following: physical therapy and massage thrice weekly and an abduction splint to be worn during the daytime only. Two manipulations, with the patient under anesthesia, were performed, both of which aggravated the pain for approximately six weeks. Examination revealed the following conditions: There was slight flattening of the posterior portion of the deltoid muscle as compared with the opposite side. When she was asked to point to the most painful area, the index finger was placed over the attachment of the subscapularis tendon. On abduction, acute pain was experienced at the 75 degree angle. After this angle was passed, localized pain on pressure disappeared (Dawbarn's sign). External rotation caused acute pain, and internal rotation caused much less. Muscle power was good when not limited by pain (fig. 4*A*). Roentgen examination gave negative results. The preoperative diagnosis was incomplete or partial rupture of the supraspinatus tendon.

Operation was performed on December 15. Because of their importance, the operative position and incision used will be described in detail. The patient was placed on the side and an assistant assigned to hold the forearm during the operative procedure. This position is essential to adequate exposure of the posterior compartment. Further, manipulation (rotation) is essential during the operative procedure to facilitate fixation and closure.

Fig. 4.—*A*, photograph (case 1) illustrating bizarre symptoms accompanying a simple complete rupture of seven and one-half years' duration. The patient had ability to abduct and fair muscle power but severe pain from this point up to the 90 degree angle and extreme pain on external rotation. *B*, postoperative photograph illustrating complete recovery, as evidenced by a painless shoulder, with complete return of function. The patient is now able to extend her arm completely and to elevate the flatiron to the overhead position.

The incision used has been variously attributed to Cubbins and co-workers, Henry, Thompson, and Mayer.[12] Investigation, however, reveals that Cubbins and associates gave the first complete description of it as it is used at present. It will therefore be spoken of as the Cubbins or "acromioclavicular" incision.[12a] Should a more detailed and completely illustrated description be desired, one is referred to the original article. A 6 inch (15 cm.) vertical cutaneous incision is made on the anterior surface of the humerus, just external to the coracoid process. It is then turned laterally and continued just external to the semicircular curve of the bony acromioclavicular arch. The incision should pass well to the posterior surface of the shoulder joint. The flap of skin is then reflected downward, exposing the deltoid muscle. The index finger is then inserted into the muscular interspace between the pectoralis major and the deltoid muscle and the deltoid muscle is elevated. It is then separated close to its final attachment to the clavicle, the acromioclavicular joint and the acromion process. At this point, which is well above all branches of the circumflex nerve, the deltoid muscle is relatively avascular. The anterior two thirds of the deltoid muscle is reflected downward as a flap. This is difficult, as these lesions are invariably accompanied by dense bursal adhesions.

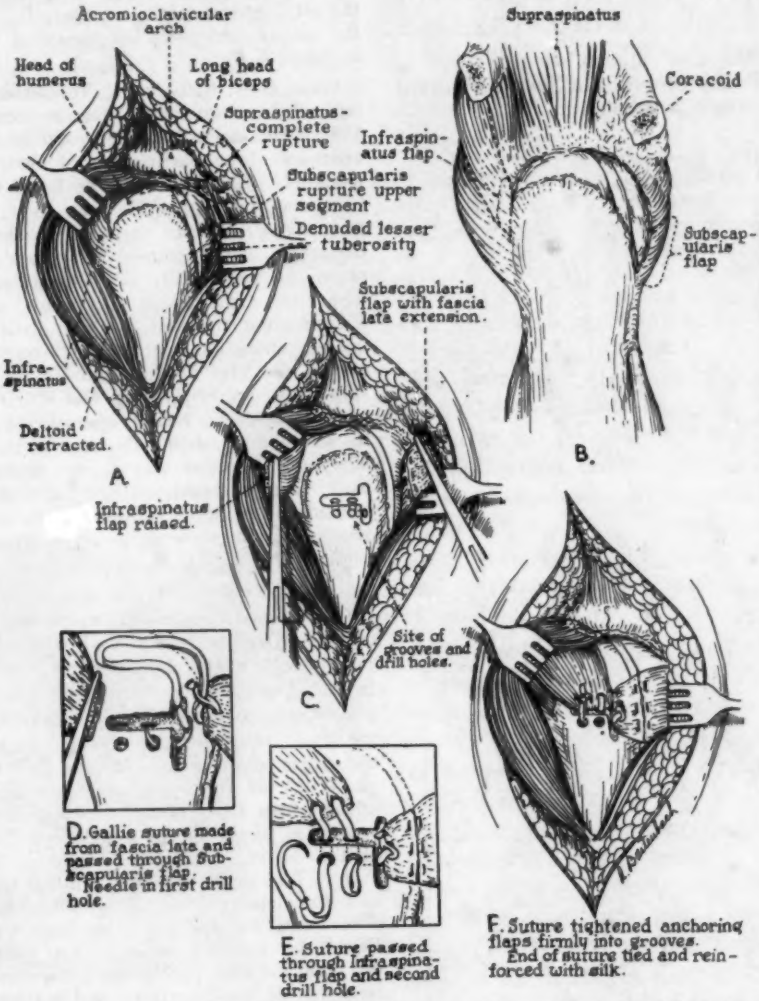
Acromioclavicular arch
Head of humerus
Long head of biceps
Supraspinatus - complete rupture
Subscapularis rupture upper segment
Denuded lesser tuberosity
Infraspinatus
Deltoid retracted.
A.
Supraspinatus
Coracoid
Infraspinatus flap.
Subscapularis flap
B.
Subscapularis flap with fascia lata extension.
Infraspinatus flap raised.
Site of grooves and drill holes.
C.
D. Gallie suture made from fascia lata and passed through Subscapularis flap. Needle in first drill hole.
E. Suture passed through Infraspinatus flap and second drill hole.
F. Suture tightened anchoring flaps firmly into grooves. End of suture tied and reinforced with silk.

Fig. 5.—*A*, drawing illustrating complete rupture of the supraspinatus tendon, with extension of the tear into the upper portion of the infraspinatus and the subscapularis tendon. Anteriorly, the tendon of the long head of the biceps muscle is divested from all its attachments and the lesser tuberosity is denuded. Posteriorly the tear extends into the upper portion of the infraspinatus tendon. *B*, diagram illustrating the outline of the posterior and anterior flaps used to repair complete avulsion of the upper segment before separation. For illustrative purposes, all overlying structures (deltoid muscle, outer end of clavicle and acromion process) have been removed. *C*, illustration of a T-shaped trough on the lateral upper surface of the humerus and a right angle anterior two way drill hole. The two flaps are now separated preparatory to transplantation. The subscapularis tendon has been lengthened by a fascial tab. *D*, diagram illustrating steps in the use of the running fascia lata suture, which is inserted into the bony groove with entrant drill holes. *E*, relation of the fascia lata suture to the bony tunnels and troughs. By this means, closure can be made with a single running suture.

In view of the clinical findings, the pathologic changes were surprising. The upper transverse line of the greater tuberosity was completely bare of any tendinous attachment, indicating complete rupture of the supraspinatus tendon with retraction (fig. 4 *A*). The tear did not extend into the capsular tendons of the neighbor-

ing muscles. The bursa was injected and chronically inflamed, and the inner and outer layers were adherent at many points. The tendon could not be pulled down without cutting through the acromioclavicular arch. To avoid this, a 1 inch (2.5 cm.) segment of the neighboring and visible infraspinatus muscle was separated from its bony attachment and mobilized. A transverse groove 1 inch (2.5 cm.) long was made on the lateral surface of the humerus just below the transverse line of the greater tuberosity. The groove was placed so that its axis was at right angles to the direction of the muscle fibers of the transplanted flap. Two entrant drill holes were made at each end and at right angles to the end of the groove. The infraspinatus muscle transplant was then fixed into the groove by means of silk sutures. The edges of the transplant were then sutured to the neighboring muscles, in front and in back, in order to reestablish continuity (fig. 3 *B*). A previously prepared abduction splint, with the arm maintained at the 60 degree angle, was applied. After four months the patient had complete return of function, as shown in figure 4 *B*.

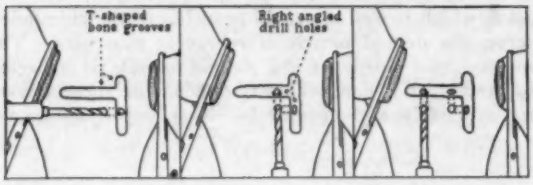

Fig. 6.—Serial diagrams illustrating the steps in preparing T-shaped bony grooves and the exact manner of preparation of entrant drill holes.

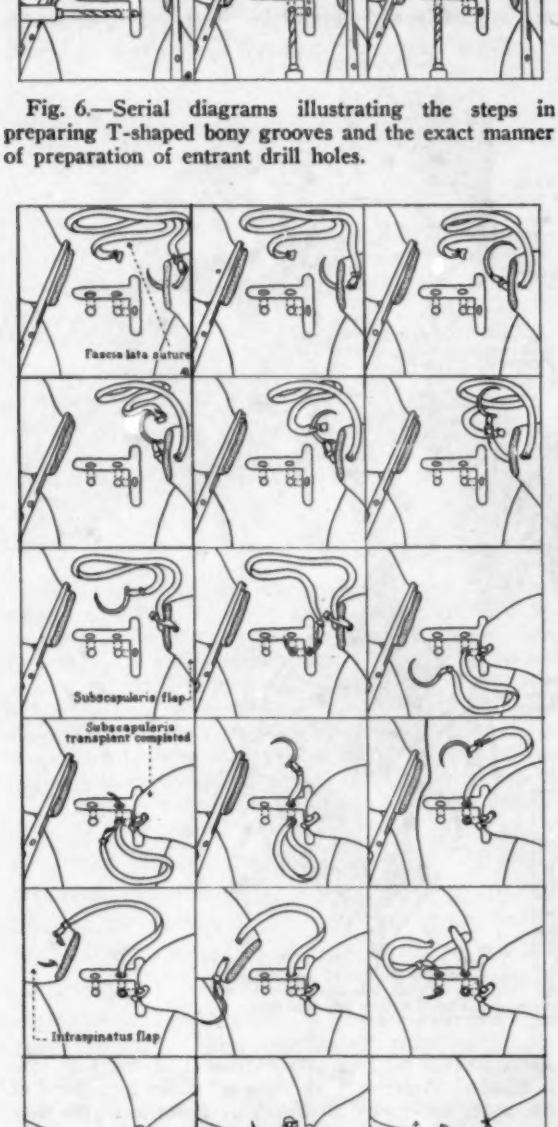

Fig. 7.—Serial diagrams illustrating the steps in transplantation of a double flap, with a single running Gallie suture. The flap from the subcapsularis muscle is always placed in the vertical groove and the flap from the infraspinatus muscle in the transverse groove.

Case 2.—J. E. G., aged 70, was injured while carrying a bucket of water. The accident occurred Feb. 3, 1942. He slipped and fell, and in his doing this the arm was bent backward and under the body. Immediately after the injury, he found that he was unable to abduct his arm. He was referred to a physician and given physical therapy, consisting of heat and massage. He attempted to return to work on two occasions and finally was suspected of malingering. The first examination was made on June 15, 1942. Examination revealed that the patient was unable to initiate abduction, although he could feebly flex and extend the arm at the shoulder joint. An abduction splint was prescribed and was worn at the 45 degree angle six weeks before operation. After two weeks he was able to abduct the arm to the 45 degree angle, but this movement was always accompanied by great pain. Both external and internal rotation were severely limited and painful. Atrophy of the deltoid muscle was severe. There were no areas of sensory anesthesia.

Operation was performed on July 29. The position and the incision were similar to those described in case 1. Once the deltoid muscle had been reflected, a crescentic tear was visualized, which started at a point just anterior to the upper portion of the bicipital groove. It then extended posteriorly to include that upper portion of the subscapularis muscle which inserts into the lesser tuberosity, and farther posteriorly to include the entire supraspinatus tendon and the upper 1 inch (2.5 cm.) of the insertion of the combined capsular-infraspinatus teres minor muscles. The tendon of the long head of the biceps muscle ran through the middle of the defect, completely devoid of attachments (fig. 5 *A*). This is the type of lesion that usually is described as a complete avulsion. It would be better described as a complete tear of the upper segment of the capsule. From the anterior edge of the bicipital groove the retracted but still visible upper portion of the subscapularis muscle was recovered and a 1 inch (2.5 cm.) flap prepared (fig. 5 *B*). At the posterior end of the tear, the retracted infraspinatus muscle was recovered with an adjoining portion of the supraspinatus muscle, and a similar flap was made. Two bony grooves, one transverse and the other at right angles to the anterior end, were made on the lateral surface. A Gallie fascial suture was obtained from the thigh. At the same time, a triangular tab of fascia was secured. This was sutured to the end of the tendon of the subscapularis

12. (*a*) Cubbins, W. R.; Callahan, J. J., and Scuderi, C. S.: The Reduction of Old or Irreducible Dislocations of the Shoulder Joint, Surg., Gynec. & Obst. **58**: 129 (Feb.) 1934. (*b*) Henry, A. K.: Exposures of the Long Bones and Other Surgical Methods, Bristol, John Wright & Sons, Ltd., 1927. (*c*) Thompson, J. E.: Anatomical Methods of Approach in Operations on the Long Bones of the Extremities, Ann. Surg. **68**:309 (Sept.) 1918. (*d*) Mayer.[6]

muscle, to lengthen it. This is necessary, as it is frequently too short for fixation without tension (fig. 5 *F*). The anterior flap was fixed into the anterior groove and the posterior flap into the vertical groove. Entrant drill holes were made at right angles to the grooves, as shown in the figures (fig. 5 *C*). Closure was made with a running suture which is difficult to describe but simple when illustrated (figs. 5 *D*, *E* and *F*, 6 and 7).

The edges of the various flaps were then sutured to each other and to the remaining muscles in front and in back, and thus continuity was reestablished. The patient's arm was again placed in the previously worn abduction splint at the 45 degree angle. Owing to the advanced age of the patient and the chronicity and severity of the lesion, recovery was slow. For fear of lost fixation, no movement was permitted for six weeks. After this period, gradual increasing active motion was encouraged. This was first done by loosening the straps that fixed the arm and forearm to the brace and then encouraging abduction exercises on the splint. Later stretching and rotating exercises increased the range of motion. The patient was last seen in July 1943 and at that time had a completely painless shoulder, although abduction could be brought only to the 60 degree angle. He was able to carry a 20 pound (9 Kg.) sandbag at the extreme range of his abduction.

CASE 3.—In this case the accident occurred on June 30, 1942, when the patient fell 18 feet (5.5 meters) from a scaffold. The patient was a robust man 60 years old. There was immediate and severe pain in the right shoulder. He could not initiate abduction, and there

Fig. 8.—*A*, photograph of the patient in case 3, taken before operation, illustrating inability to initiate abduction, with extreme pain on slight rotation. *B*, photograph taken after operation illustrating painless shoulder and range of abduction and external rotation. *C*, photograph taken after operation illustrating painless shoulder and ability to carry 20 pounds (9 Kg.) of sandbags with the arm at the 60 degree angle of abduction.

was pain on pressure over the entire upper end of the humerus. When the arm was slowly and passively abducted, the painful pressure point disappeared. The rotatory movements were acutely painful. When preliminary immobilization gave little relief, operative repair was advised and performed on August 24. Avulsion of the upper capsular segment was found, which was similar and only slightly less extensive than that described in the preceding case. The operative procedure was similar in every particular. When last seen, in July 1943, he was able to abduct his arm to the 90 degree angle and place his hand in back of his head with only slight discomfort at the extremes of rotation. He could carry 20 pounds (9 Kg.) of sandbags with the arm fully abducted. The patient was well pleased and was able to do farm work (fig. 8).

EVALUATION

Most men especially interested in the shoulder joint are aware of the fact that there is much confusion as regards both diagnosis and treatment. Codman, whose works are generally considered authoritative, recognized this condition in the following words [2]:

> The reader who has the patience to finish this book will inevitably remain confused about the lines of distinction which I have attempted to draw among the six most common clinical entities which affect the shoulder, i. e., complete and incomplete tendon ruptures, rim rents, calcified deposits, tendinitis and arthritis. In fact, I must leave the reader puzzled, for I am still puzzled myself.

This statement is as true today as when it was first made. This can be verified by a study of a recent article by Wilson,[13] which listed considerably more than one hundred references, all taken from the literature of the past twenty years. A study of these articles indicates that there is complete disagreement regarding every diagnostic and therapeutic phase as they pertain to painful shoulder.

This paper has attempted to correlate many conditions that are now considered as separate entities. As an example, abnormal calcification about the shoulder is considered as positive proof of the present or past existence of rupture. The present impression is that it is found only in incomplete small tears. It must be freely admitted that clinical statistics in recent articles and in this paper on the incidence of complete rupture are probably much too low. The fact that postmortem examination finds large rents in the capsule in 15 to 20 per cent of the bodies whereas clinical studies of even a large number of patients have failed to reveal any such frequency needs explanation. As in case 1, many of these patients are treated conservatively with varying diagnoses for years. It may even be that after a lapse of years they may become relatively free from pain by a process of adaptation. The patient learns to avoid certain positions which have been found to be painful.

In line with the preceding comments, critical issue must be taken with two statements that are made regarding rupture of the supraspinatus

13. Wilson, C. L.: Lesions of Supraspinatus Tendon, Arch. Surg. **46**:307 (March) 1943.

tendon. The first is that the lesion never occurs under the 30 year age level. The initial injury in the first case described in this article occurred at the age of 19. In another case of partial rupture the patient was 26 years old when operated on. The second statement that should be critically reviewed is that this is a self-limited disease of only two years' duration. In the first case in this series there was a history of pain for seven and one-half years. In another the patient had a history of pain of seventeen years' duration.

As regards the use of the Cubbins exploratory and operative incision that has been described, it is my belief that it should be adopted universally. It affords adequate exposure for almost any operative procedure about the shoulder that can be brought to mind. Of even more importance is the fact that splitting of the deltoid muscle is avoided and with it injury to branches of the circumflex nerve. It is difficult to explain why it should be so rarely used.

The operative procedure that has been described, namely, the use of substitution flaps, has given me confidence, not formerly possessed, in my ability to cope with large scale rupture.

As an experiment in pathologic physiology, study of these cases before and after operation affords powerful support for a hypothesis that has been previously advanced.[9] It is as follows:

"Movement of the shoulder demands both fixation of the glenoid and the head of the humerus, with effort increasing the demand. Two distinct muscle systems are involved in effecting this. Dysfunction of any (single) muscle component will seriously disturb the fine muscle balance (in other components) essential to normal shoulder movement."

CONCLUSIONS

Complete rupture of the supraspinatus tendon is a common lesion. Although it is rarely diagnosed clinically, postmortem statistics show that it is found in 15 to 20 per cent of the shoulders of unselected cadavers after the age of 30.

Subacromial bursitis, abnormal calcification, periarthritis, monarticular arthritis of the shoulder joint and rupture of the tendon of the long head of the biceps muscle are frequently not clinical entities but are complications and sequelae that accompany and mask rupture of the supraspinatus tendon.

The lesion occurs under the 30 year age level and is not a self-limited disease of only two years' duration.

Chronic painful shoulders that do not respond to conservative treatment should be more frequently explored, with the Cubbins transacromioclavicular incision. With it two indispensable prerequisites are met. It affords sufficient exposure for the recognition of pathologic lesions. At the same time adequate surgical exposure is given for the immediate repair of the varying types of rupture of the supraspinatus tendon that are disclosed.

Three cases of complete rupture were found in a series of 51 cases of chronically painful shoulder. In 1 case the condition was a simple rupture which involved the supraspinatus tendon alone, and in 2 there was complete rupture involving not only the supraspinatus but portions of the adjoining tendons as well.

The method of repair described avoids cutting through the bony acromioclavicular arch. Not only is postoperative instability avoided, but there is considerable saving in operative time.

Postoperative results indicate that pain and loss of function following complete rupture of the supraspinatus tendon are due not to the defect per se but to a disruption of capsular continuity. The loss of this supraspinatus link seriously affects the function of the more important neighbors, the subscapularis and infraspinatus teres minor muscles.

Restoration of capsular continuity, however accomplished, is followed by relief from pain and great improvement in function.

9615 Brighton Way.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1943

A REVIEW PREPARED BY AN EDITORIAL BOARD OF THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

XVI. CONDITIONS INVOLVING THE LOWER PART OF THE BACK

PREPARED BY HAROLD H. KUHN, M.D., DURHAM, N. C.

A review of the papers published during 1943 on pain in the lower portion of the back and sciatica shows the continued interest of American writers in posterior herniation of intervertebral disks. Most writers present a review of previous papers, modifications in operative technic and follow-up statistics. The use of contrast mediums for myelography finds fewer advocates.

Deery [535] discusses herniation of the nucleus pulposus as a complication of preexisting instability of the lower part of the back. He divides patients with sciatic pain into three general groups: (1) those with sciatic pain only, (2) those with sciatic pain and minimal pain low in the back and (3) those with a history of disability in the lower portion of the back preceding the development of sciatica. He describes the typical history, signs and symptoms and outlines diagnostic measures. Lumbar puncture was carried out for all patients treated by the author, but he does not recommend the use of contrast mediums. He describes the development of operative treatment and points out that generally fusion alone for instability will not relieve sciatic pain. He recommends for patients of groups 2 and 3 fusion combined with excision of the ruptured intervertebral disk.

Hyndman, Steindler and Wolkin [536] discuss herniated intervertebral disk and the use of myelography with iodized poppyseed oil and the procaine test in the differential diagnosis. Two general types of patients are covered in this paper: (1) those definitely having root compression with sciatic neuritis and (2) patients with myofascial syndromes which provoke reflex sciatica. Sixty-three laminectomies were done for ruptured intervertebral disks, and 50 herniated disks were found. Ninety-two per cent were found at or below the fourth or fifth lumbar interspace. The authors used myelography with iodized poppyseed oil in only the atypical cases. One patient had a negative result with iodized oil but a disk was found. Three patients had clinical signs and symptoms of a ruptured intervertebral disk, but on exploration no ruptured disk was found. Five patients showed filling defects, but on exploration no ruptured disks were found. The operation is dealt with in detail, and they sound a note of caution against too minimal exposure, particularly when exploration is made on the basis of clinical findings only and without the aid of studies with iodized oil. When "trigger points" are present, the authors recommend the injection of 1 per cent procaine hydrochloride, which generally will relieve the pain low in the back as well as the sciatic neuralgia. The authors point out that the procaine test is a differentiating point between sciatic pain from referred sources and direct pressure mechanism, such as is seen with ruptured intervertebral disks. When the procaine test eliminates the "trigger area" as well as the pain over the area of distribution of the sciatic nerve, they recommend further conservative treatment.

Ver Brugghen [537] reports on 75 patients with pain low in the back and sciatica, 66 of whom had ruptured intervertebral disks. Ninety-three per cent of these occurred at the fourth and fifth lumbar interspaces, with 58 per cent at the latter. There were three disks between the third and fourth lumbar vertebrae, one between the fifth and sixth and one with multiple herniations. The author states that he has seen 8 cases of complete herniation which produced complete paraplegia, simulating a transverse lesion of the cauda equina. He discusses the anatomic and pathologic features of herniated nucleus pulposus and presents statistics on signs, symptoms and findings. Sixteen injections of iodized poppyseed oil were made, with three positive

535. Deery, E. M.: Herniation of the Nucleus Pulposus as a Complication of Preexisting Low Back Pain, Surg., Gynec. & Obst. **77**:79-86 (July) 1943.

536. Hyndman, O. R.; Steindler, A., and Wolkin, J.: Herniated Intervertebral Disk: A Study of the Iodized Oil Column, the Procaine Test in Differential Diagnosis from Reflected Sciatic Pain, J. A. M. A. **121**:390-401 (Feb. 6) 1943.

537. Ver Brugghen, A. H.: Herniated Nucleus Pulposus: A Report of Seventy-Five Cases Examined and Operated on by One Observer, Dis. Nerv. System **4**:165-177 (June) 1943.

errors and two negative errors. Twenty-three injections of air were made, with six positive errors. No contrast medium was used in 27 of the 66 cases, and no errors were made. He reports that the results were excellent in 15 per cent of his cases, good in 68 per cent, fair in 11 per cent and poor in 6 per cent.

McEachern and Cone [538] review the symptoms and findings in patients with ruptured intervertebral disks in the fourth and fifth lumbar areas. They point out that hyperalgesia is occasionally found in the lower portion of the back and report cases in which there was referred pain into the flank and abdomen, which needed thorough gastrointestinal and genitourinary studies. The authors believe that the referred pain may be due to intersegmental nerve supply to the dura and the ligamentous structures. Determinations of protein were done on spinal fluid withdrawn below the protrusion in 24 cases. Three samples of 3 to 4 cc. were collected in separate tubes, and the protein content was compared to that found in control cases. A greater drop in the protein level from the first to the third sample was noted in the control cases. The results were too scattered to permit use of this method as a reliable clinical tool.

Haynes [539] reports 21 cases of ruptured intervertebral disk at the Lovell General Hospital. Eleven of the patients were discharged from the Army because the changes existed prior to enlistment. Ten patients were operated on, 9 of whom returned to full military duty and 1 of whom was discharged from the Army because of psychoneurosis. The author states that the percentage of cures in the military services must be high if surgical treatment is to be justified. He stresses conservatism, accurate diagnosis, elimination of psychoneurotic patients and careful care before and after operation. The author believes that in selected cases 90 per cent of patients who have been operated on can return to full military combat duty. He reports an average disability of six weeks.

Echols [540] describes the surgical treatment of ruptured intervertebral disks. He presents indications, operative technic and results from combined disk fusion operations. The author operated on 170 patients, 100 of whom he describes as having excellent results.

538. McEachern, D., and Cone, W. V.: Clinical Points on Ruptured Intervertebral Discs: Low Back Pain and Sciatica, Canad. M. A. J. **49**:33-35 (July) 1943.

539. Haynes, W. G.: Problem of Herniated Nucleus Pulposus in the Military Service, War Med. **3**:585-595 (June) 1943.

540. Echols, D. H.: Surgical Treatment of Sciatica Due to Rupture of an Intervertebral Disk, S. Clin. North America **23**:1335-1353 (Oct.) 1943.

Young [541] discusses the etiologic factors in painful back. He divides the patients into two main groups: (1) those with pain referred from abdominal or pelvic viscera and with full range of painless motion in spine and hips and (2) those patients with pain due to local conditions of the back, arising from: (*a*) muscles, fascia and ligaments, (*b*) nerves and perineural structures, (*c*) intervertebral and sacroiliac joints and (*d*) bones, which are inflammatory, neoplastic or involved in Paget's disease. He gives statistics on 770 patients, both civilian and military. Diagnostic tests and treatment are described. Brailsford, in a conjoint paper, calls attention to roentgenographic interpretation of alinement of the vertebral column and the adjacent soft tissue structures. He discusses recognition of alteration in the individual parts and the responsible pathologic condition.

Hare and Langs [542] discuss pain low in the back and sciatica, with special reference to roentgen interpretation. Anatomic abnormalities are discussed in detail, with emphasis on roentgenographic interpretations. A method for oxygen myelography is given in detail. After injection, the table is immediately tilted downward 30 degrees, and stereoscopic exposures are made with the patient in the true lateral position with the painful side uppermost. Anteroposterior views and a 45 degree view of the lumbosacral angle are then made. After injection of oxygen, there is a period of twenty minutes for roentgen examination, before the oxygen disappears. This method was used in 100 consecutive cases in the New England Baptist Hospital, with 85 per cent accuracy. The authors believe that there is a definite decrease in postoperative headaches following this procedure.

Breck and Basom [543] describe flexion treatment for pain in the lower part of the back in patients who have narrowed fourth or fifth lumbar interspaces. This treatment is based on the observations of Love, Walsh and Schachtschneider, who noted that in dissected specimens kyphotic flexion caused the protruded disk to be drawn in and that hyperextension of the spinal column caused the disk to protrude farther. Treatment consists of placing the patient in bed

541. Young, R., and Brailsford, J. F., in Discussion on Painful Back in Soldiers and in Industrial Workers, Proc. Roy. Soc. Med. **36**:211-218 (March) 1943.

542. Hare, H. F., and Langs, L. W.: Low Back Pain and Sciatica with Special Reference to Roentgen Interpretation, U. S. Nav. M. Bull. **41**:1263-1272 (Sept.) 1943.

543. Breck, L. W., and Basom, W. C.: The Flexion Treatment for Low-Back Pain: Indications, Outline of Conservative Management, and a New Spine-Fusion Procedure, J. Bone & Joint Surg. **25**:58-64 (Jan.) 1943.

in a semisitting position, with flexion of the lumbar portion of the spine, the hips and the knees. Physical therapy with flexion exercises accompanies this treatment. Inexpensive apparatus which can be used in the home is illustrated. For those patients needing surgical treatment, they describe a modified spinal fusion operation in which bone grafts are placed across the laminal arches in the customary fashion. After subluxation of the facets has been reduced and the interspaces restored to normal, if fusion is indicated the customary fusion is carried out and an H-shaped bone block is placed between the spinous processes of the involved vertebrae. The additional graft is used to prevent subluxation of the facets and postoperative narrowing of the intervertebral space. The authors report on 2 patients on whom this procedure was carried out, with good results. [ED. NOTE.—A similar procedure has been described by Bosworth.]

Stewart and Owen [544] report changes in the intervertebral disk at the third lumbar vertebra in a patient with a history of repeated spinal puncture. They discuss the possibility of perforation of the annulus fibrosis with escape of nuclear material, leading to collapse of the intervertebral disk and subsequent changes in the bodies of the vertebrae. They refer to 4 similar cases reported by Everett and Epps. The patient gained relief from symptoms by rest alone for eight weeks.

Fisher [545] reports a case of pain low in the back with radiation into both lower extremities, which was accentuated by chiropractic manipulation. A large ruptured fifth lumbar intervertebral disk was removed. [ED. NOTE.—I have observed 2 similar cases and believe that any forceful extension of the spine is likely to produce this injury.]

Hiss [546] makes a plea for examination of the feet in all cases of pain in the lower portion of the back. He states that of 80,000 patients whose feet were examined in his clinic 40,000 had backache and that in 50 per cent of these the pain in the back was due to foot disorders.

Hershey [547] calls attention to osteoarthritis of the sacroiliac joint and its relationship to pain of sciatic radiation. Dissections were carried out on 64 cadavers, and the lumbosacral portion of the trunk was found to be in direct contact with the sacroiliac joint where it traverses the joint in its lower third. Osteoarthritis was found in only 25 per cent of the sacroiliac joints studied. The upper portion of the origin of the pyriformis muscle was found to lie medial to the lumbosacral portion of the trunk in all cadavers but never to lie between the trunk and the joint. He believes that the changes observed would produce direct irritation of the lumbosacral portion of the trunk.

Pitkin [548] summarizes the results in 53 patients who were operated on for instability of the lumbosacroiliac joints by means of fusion of the lumbosacral area, which he described in 1937. The operation is a modification of the Verrall tie rod graft. The author states that his operation offers the advantage of immediate immobilization without any form of external support. Seventy per cent of the patients had good anatomic and functional results, 20 per cent were moderately improved and 10 per cent were classed as anatomic and functional failures. [ED. NOTE.—This seems to require extensive and detailed grafting when a more simple fusion would be adequate.]

Thiltgen [549] reviews the anatomy of the lumbosacral plexus. He reports a series of sacral epidural injections and describes the technic used. He points out that toxic manifestations may occur and that death has followed entrance of the solution into the subarachnoid cavity or into the blood stream.

Vinke and White [550] studied roentgenograms of the lumbosacral area in 300 children between the ages of 5 and 15. They found only 3 cases of narrowing of the lumbosacral joint which could be considered congenital. They state that Williams in his series found only 1 case of narrowing of the lumbosacral joint which could be considered congenital. The authors report on 6 adult patients with narrowing of the lumbosacral joint in whom pain was attributed to other causes. The roentgenograms which revealed narrowing showed associated anomalies, with partial and bilateral sacralization. They conclude that a narrowed lumbosacral joint may be a

544. Stewart, V. A. F., and Owen, A.: A Case of Arthritis of the Lumbar Part of the Spine Following Lumbar Puncture, M. J. Australia **2**:295-296 (Oct. 9) 1943.

545. Fisher, E. D.: Report of a Case of Ruptured Intervertebral Disc Following Chiropractic Manipulation, Kentucky M. J. **41**:14 (Jan.) 1943.

546. Hiss, J. M.: Backaches and Feet, Hahneman. Monthly **78**:385-391 (Sept.) 1943.

547. Hershey, C. D.: The Sacro-Iliac Joint and Pain of Sciatic Radiation, J. A. M. A. **122**:983-986 (Aug. 7) 1943.

548. Pitkin, H. C.: Internal Brace for the Low Part of the Back, Arch. Surg. **46**:755-758 (May) 1943.

549. Thiltgen, W. S.: Sacral Epidural Injection of Normal Saline in the Treatment of Sciatica, Certain Cases of Low Back and Pelvic Pain (with Case Reports), M. Rec. & Ann. **37**:688-689 (Nov.) 1943.

550. Vinke, T. H., and White, E. H.: Congenital Narrowing of the Lumbosacral Space, Surg., Gynec. & Obst. **76**:551-555 (May) 1943.

congenital anomaly and does not necessarily indicate injury to the intervertebral disk.

Hoge [551] discusses pain in the lower portion of the back from the viewpoint of a gynecologist. The author presents numerous statistics on pelvic conditions which produce pain low in the back, their treatment and the results. He describes the gynecologic cause of backache and urges women with backache to have a gynecologic investigation.

McBride [552] discusses nonskeletal injuries to the lower part of the back. He calls attention to postural strain or sprain of the ligaments in the iliolumbar, lumbosacral or sacroiliac areas. The author emphasizes accurate localization and points out the distinguishing characteristics and customary tests.

Steindler [553] stresses accuracy in localization of pain on an anatomic ligamentous basis. He discusses pain low in the back where "trigger points" are located. He explains pain on a basis of stretch to the ligaments. He mentions the value of injection of procaine hydrochloride to differentiate true sciatica or sciatic neuritis from referred pain. Emphasis is given to accuracy in localization of the lesion.

Herzmark [554] reports a case of herniation of the cauda equina following laminectomy on the sacrum for removal of iodized poppyseed oil. The herniation was reduced and the sacral defect repaired with fusion of the lumbosacral area. Use of iodized poppyseed oil and laminectomy for its removal are considered inadvisable.

551. Hoge, R. H.: Low Backache from the Viewpoint of the Gynecologist, Virginia M. Monthly **70:** 598-601 (Dec.) 1943.

552. McBride, E. D.: Nonskeletal Low Back Injuries, M. Rec. & Ann. **36:**238-241 (Feb.) 1942.

553. Steindler, A.: Las lumbalgias; su diagnóstico, Día méd. **14:**900-904 (Sept. 7) 1942.

554. Herzmark, M. H.: Herniation of Cauda Equina Following Laminectomy of Sacrum, J. Bone & Joint Surg. **25:**197-201 (Jan.) 1943.

Wilensky [555] calls attention to the anatomic relationship of muscles, fasciae, ligaments, blood vessels and nerves in the region of the pelvic outlet. He discusses their possible relation to pain low in the back, sciatica and coccygodynia. He confirms Thiele's report that spasm of the levator ani, coccygeus or piriformis muscle causes such symptoms. Relief is obtained by massage of these muscles. The author presents 8 illustrative cases of 28 studied.

Toumey [556] presents a study of 95 cases of metastatic cancer of the spine, from a total of 2,067 cases of cancer. Roentgenograms frequently fail to reveal metastasis, particularly in the early stage. During a four year period (1936 to 1940) 326 cases of mammary carcinoma were observed, and in 42 the patients showed spinal metastasis. Of 140 cases of prostatic carcinoma, associated spinal metastasis occurred in 11. Hodgkin's disease of the spine was encountered in 7 cases. He discusses palliative therapy. Roentgen therapy often relieved pain and allowed local repair. Subarachnoid injection of alcohol is subject to complications and frequently does not relieve pain. Chordotomy is advisable for inoperable conditions. Orchiectomy deserves further trial for advanced carcinoma of the prostate.

Schumacher [557] discusses the evaluation of disability due to injuries to the lower part of the back. He discusses McBride's and Kessler's methods for computing disability and presents disability charts of specific injuries. [ED. NOTE. —The charts show all components of disability and are valuable references.]

555. Wilensky, T.: Levator Ani, Coccygeus and Pyriformis Muscles: Agents in Causation of Coccygodynia, Superior Gluteal Pain and Sciatic Syndrome, Am. J. Surg. **59:**44-49 (Jan.) 1943.

556. Toumey, J. W.: Metastatic Malignancy of the Spine, J. Bone & Joint Surg. **25:**292-305 (April) 1943.

557. Schumacher, F. L.: Evaluation of Disability in Low Back Injuries, Radiology **41:**18-22 (July) 1943.

XVII. INFECTIONS OF BONES AND JOINTS

PREPARED BY PAUL C. COLONNA, M.D., PHILADELPHIA

McIntosh and Selbie [558] point out that in a previous paper they showed the value of sulfonamide drugs in preventing gas gangrene in mice under certain conditions. This report is based on a further study of the subject, in which they used zinc peroxide, proflavine and penicillin on experimental animals.

They point out that the clostridiums are in the nesting stage when the wound is infected and that only through the use of some inciting agent, which would appear to be the calcium ion, is the organism capable of producing an infection. In their experiments toxin-free clostridiums were used, and with the calcium chloride present they produced both a local and a general infection. With this technic, they found that in local infection zinc peroxide is apparently of no value in preventing the development of Clostridium welchii

558. McIntosh, J., and Selbie, F. R.: Zinc Peroxide, Proflavine and Penicillin in Experimental Clostridium Welchii Infections, Lancet **2:**750-752 (Dec. 26) 1942.

infection in mice after the organisms have invaded the tissues.

Proflavine was of greater value than sulfanilamide and as good as sulfathiazole for local prophylaxis. Its use as a dressing for wounds warrants further investigation. Penicillin injected at the site of infection within three hours after the infection is a powerful prophylactic and superior to proflavine or sulfonamide compounds. [ED. NOTE.—This is an interesting and useful paper. It is hoped that the authors will continue this experimental work.]

Scheman, Lewin, Sideman and Janota [559] report on a method of producing osteomyelitis in rabbits and dogs by intrametaphysial injection of sodium morrhuate and Staphylococcus aureus one week after administration of immunizing doses of the organism. They were able to produce panosteitis. The clinical course in the animals ran from the acute to the chronic stage in three weeks and closely resembled the human variety. If no organisms are injected complete regeneration of bone occurs about three and one-half weeks after injection of sodium morrhuate. The authors contend that in man as well as in animals the earliest lesion in osteomyelitis is damage to bone tissue, and in none of their animals was there any evidence of vascular thrombosis from sodium morrhuate. In none of their animals did sinuses develop without surgical treatment, although some were allowed to die from the osteomyelitis itself. They suggest that in human beings septicemia rather than bacteremia may be a valuable criterion for withholding surgical operation. They conclude with an outline of proposed experiments which should be helpful in evaluating the various therapeutic approaches to the problem of osteomyelitis. [ED. NOTE.—This work opens up a most practical method of producing osteomyelitis that clearly simulates the infection in human beings.]

Weaver and Tyler [560] produced staphylococcemia in 205 rabbits, with resultant hematogenous osteomyelitis in 39 per cent. This report is based on their difficulties and conclusions. Young rabbits, 6 to 8 weeks old and weighing 500 to 750 Gm., were found best suited for this study, for they were considered of an age comparable to the first decade in childhood. A twenty-four hour broth culture of hemolytic Staph. aureus (0.02 cc.) was intravenously inoculated into 205 rabbits. No roentgenographic or microscopic studies were made, but 147 macroscopic abscesses of bone were found in 80 of these rabbits, with about 80 per cent occurring in the metaphysial area. The complications encountered, which, they note, are rare in human beings, were frequent convulsions, massive hemorrhage distributed especially in the muscle tissue and an occasional attack of pneumonia.

They conclude that while the availability and the cost of the rabbit make it a convenient animal, a sturdier animal is more desirable. The authors feel that sulfathiazole in the experiment was of little value. All of the rabbits had nonoperative therapy. [ED. NOTE.—No conclusions can be satisfactorily drawn from this study, but it is of value in recording the difficulties which the authors found in a study of this sort.]

Gage [561] states that the early high mortality in acute osteomyelitis is caused from profound toxemia, with or without bacteremia. Since in over 83 per cent of cases acute osteomyelitis is due to Staph. aureus, its necrogenic toxin and its toxin with a "spreading factor" must cause extensive destruction of the osseous tissues. Bacteremia is probably due to bacterial thrombophlebitis in osseous tissue. He classifies the types of acute osteomyelitis according to the extent of systemic and local osseous involvement, which depends on the type of organism and its toxin. The profound systemic reaction so often seen in acute osteomyelitis is due to diffuse cellulitis of bone and bone marrow and lymphangitis.

The author advocates for treatment the usual general measures plus administration of sulfathiazole and antistaphylococcus serum, 60,000 to 100,000 units daily, immobilization of the involved parts and operation only when the cellulitis has localized with formation of an abscess. He states that any operation during the acute stage results in high mortality and serious disability. He cites cases reported by Butler in which the patients with positive blood cultures who were operated on early showed twenty-five times the mortality of those with negative cultures. [ED. NOTE.—No data are given on the results of treatment as outlined to compare with the results of other methods. The author mentions Butler's cases in which there is only a 2 per cent mortality with early operation and no administration of sulfonamide drugs or staphylococcus antitoxin.]

559. Scheman, L.; Lewin, P.; Sideman, S., and Janota, M.: Experimental Osteomyelitis, Am. J. Surg. **60**:371-380 (June) 1943.

560. Weaver, J. B., and Tyler, M. W.: Experimental Staphylococcaemia and Hematogenous Osteomyelitis, J. Bone & Joint Surg. **25**:791-802 (Oct.) 1943.

561. Gage, M.: Acute Hematogenous Osteomyelitis Juvenalis, Surg., Gynec. & Obst. **76**:123-124 (Jan.) 1943.

Brown and Ghormley [562] discuss 24 patients with the diagnosis of solitary eccentric (cortical) abscess in bone, 87 per cent of whom were under 30 years of age. The tibia and the femur were the commonest sites of involvement, but the fibula, radius, os calcis and patella were also involved. The clinical picture was characterized by the following: pain, generally chronic, often nocturnal and well localized; localized swelling and induration; minimal physical findings, with limping when the lesion was near a joint. The roentgenogram, almost pathognomonic, showed a small radiolucent lesion within or beneath the cortex or in the osteoplastic reactive portion of the periosteum and uniform osteosclerosis around the lesion. The pathologic finding on operation was chronic inflammation with fibrous tissue and scattered giant and round cells. Many patients showed obliteration of blood vessels in the region of the lesion. The treatment was not uniform, but two thirds of the patients had surgical excision of lesions with definite relief; 1 had irradiation with relief after a year; 1 improved with rest in bed. Two thirds of the patients had a history of trauma and focal infection or focal infection alone; cultures made from lesions for 2 patients yielded Staph. aureus and for 2 others micrococci. None of the lesions showed microscopic evidence of tumor.

Banerjee [563] classifies acute osteomyelitis into three main groups: (1) hematogenous osteomyelitis, (2) osteomyelitis due to infection from without and (3) osteomyelitis due to secondary invasion from neighboring tissues. He describes the pathologic and histologic features, and discusses the four possible types of process, including reaction to injury, formation of abscess, separation of dead from living tissue and repair. In hematogenous osteomyelitis, inflammation usually starts from the epiphysial line, the infection starting from the medulla, spreading through the cortex and finally reaching the epiphysial line, where an abscess is formed. The joints are seldom affected. Progress of the involvement depends mainly on the condition of the nutrient vessel. Osteomyelitis due to infection from without may involve only the periosteum, or, if the infection lasts long, it may affect the bone. Severe infection may spread along the medulla, and serious general infection may occur. In osteomyelitis due to infection from contiguous tissue, the periosteum may be separated from the bone, with resulting complete degeneration or thinning of the bone. If the intensity of the infection of the surrounding tissue is low, proliferating periostitis with thickened bone or spicules may develop. [ED. NOTE.—The spread of the infection into the adjacent joint is largely determined by the location of the metaphysial area, whether intracapsular or extracapsular.]

Simpson [564] discusses the anatomy and physiology of bone as related to the pathogenesis of acute osteomyelitis. The factors favorable for the localization of a pathologic process in growing bone are summarized as follows: 1. The chemical structure. Actively growing bone is more vascular, with a resultant greater concentration of calcium ions and variation in p_H. 2. The physical structure. In growing bone, the fibrils are coarse and irregular, the bone cells are large and more numerous, and the loose connective tissue is more prominent in the marrow spaces and in the surrounding irregular trabeculae of bone. This is in contrast to adult bone, which has a definite form and a basic unit (haversian system). The principle of its structure is a central vascular system about which there is bony substance. Thus the metaphysis is in a more direct relationship to the circulation than is cortical bone, which is more or less sequestrated. 3. The blood supply. The metaphysis has a more abundant supply of blood than cortical bone. Before fusion of the epiphysis the so-called end arteries are present. A septic embolus obstructing one of these vessels causes a triangular area of necrosis, from which the process extends toward the periosteum. 4. The lymphatic supply of bone. There is a lymphatic plexus in the periosteum which probably takes part in the pathogenesis of localization.

Stewart [565] reports that by using concentrated Clostridium perfringens toxoid suspended in plain tetanus toxoid, combined immunization, as evidenced by antitoxin titrations, has been demonstrated both in guinea pigs and in human beings. The antitoxin response to tetanus toxoid is greater when the toxoid is given in combination with Cl. perfringens toxoid than when it is given alone. According to previous work, guinea pigs so immunized show ability to withstand large doses of a living culture of Cl. perfringens inoculated intramuscularly. On the basis of analogy there is reason to believe that the same ability

562. Brown, R. C., and Ghormley, R. K.: Solitary Eccentric (Cortical) Abscess in Bone, Surgery **14**:541-553 (Oct.) 1943.

563. Banerjee, D. N.: Pathology of Acute Osteomyelitis in the Child, Indian M. Rec. **63**:111-116 (April) 1943.

564. Simpson, D. B.: Studies on Pathogenesis of Acute Hematogenous Ostomyelitis, Mil. Surgeon **92**: 43-50 (Jan.) 1943.

565. Stewart, S. E.: Active Immunization of Human Beings with Combined Clostridium Perfringens and Tetanus Toxoids, War Med. **3**:508-511 (May) 1943.

might be demonstrated in human beings in whom chance infection probably does not involve many spores. Antibody responses were studied in guinea pigs and in 21 human subjects.

McMilan [566] says that gas gangrene must be considered as a possibility in compound fractures, soil-contaminated wounds, extensive lacerations or crushing wounds and after abdominal operations. Roentgenograms should be taken of involved areas every four or six hours after injuries from which gas gangrene is likely to develop. This will lead to early diagnosis. The surgeon should not wait for clinical signs and symptoms. Prophylaxis consists in immediate débridement, use of sulfanilamide in the wound, administration of adequate doses of tetanus–gas gangrene antitoxin and possibly roentgenographic examination. Active therapy consists of (*a*) application of 100 r over the involved areas as soon as the diagnosis is made or strongly suspected, with repetition of the dose twice daily for three days or until the infection is controlled; (*b*) local débridement; (*c*) administration of therapeutic amounts of antiserum if the infection is more than twelve hours old or if the patient does not respond clinically to the preceding treatment. Amputation for gas gangrene per se should not be resorted to. Four hundred and fifty-four cases have been collected, in 416 of which roentgen therapy was used. There was a 14.9 per cent mortality rate (62 deaths), as compared with 49.7 per cent in Miller's 607 collected cases in which roentgen therapy was not given. [ED. NOTE.—The mortality rate in this series is striking, and I am in agreement with the treatment outlined by the author.]

Dennis [567] describes the treatment of acute osteomyelitis in 122 patients under 21 years of age. Three methods were used: (1) Hoyt's method—rest in bed with administration of sulfathiazole only, (2) Orr's treatment—saucerization of bone, packing of the wound with petrolatum gauze and application of a cast and (3) conservative immobilization—conservative operative procedures when indicated, with supportive measures, including immobilization in casts. Most of the patients with chronic osteomyelitis were treated in an expectant fashion. Sequestrectomy was performed when drainage or fever increased and roentgenographic evidence of sequestrums was present. Both the Orr treatment and primary closure after saucerization with administration of sulfathiazole were employed. Prolonged dependent drainage with drains made of lucite (polymerized methyl methacrylate) was also used. It is concluded that acute osteomyelitis in young children is more benign than in older persons. Also, prolonged rest in bed, plaster fixation and oral administration of sulfathiazole are the most effective measures in the early acute stage. In the chronic disease, the choice lies between saucerization, implantation of sulfathiazole, primary closure and plaster or prolonged dependent drainage with tubes made of polymerized methy methacrylate.

Holzwarth [568] reports 2 cases of gas bacillus infection in which he feels that the use of zinc peroxide dressings proved highly effective.

Abozin [569] describes an experimental study on cadavers to determine the roentgenographic appearance of gas introduced into the muscles of the limbs or along fascial planes. He discusses the use of roentgenograms in the diagnosis of gas gangrene and in the prognosis, including indications for amputation. He concludes that they are of great value in these respects but must not be used as a sole criterion.

Muscolo [570] emphasizes the fact that in its early stages Ewing's sarcoma roentgenographically resembles subacute or chronic osteomyelitis and in its later stages acute osteomyelitis. He describes 5 cases in detail to illustrate the difficulties in differential diagnosis. In 2 cases it was impossible to distinguish between the two conditions. In a third case final differentiation was possible only by biopsy puncture, which was done according to the technic described by Valls and co-workers.

Pinkus and Zlatkin [571] report a case of tertiary syphilis in a 30 year old Negro woman who was suffering from cutaneous lesions and painful swelling of the left ankle. She had been receiving antisyphilitic treatment for several years. Roentgen examination showed that the lower end of the tibia was involved. There was thick-

566. McMilan, K. D.: Gas Gangrene; Analysis of Four Hundred and Sixteen Collected Cases Treated by Roentgen Therapy with Thirteen New Cases, West. J. Surg. **51**:187-192 (May) 1943.

567. Dennis, C.: Experience with Hematogenous Osteomyelitis in Children at University of Minnesota Hospitals, Journal-Lancet **63**:134-137 (May) 1943.

568. Holzwarth, F. K.: Zinc Peroxide: Valuable Adjunct in Treatment of Gas-Bacillus Infection and Traumatic Wounds, J. Bone & Joint Surg. **25**:177-184 (Jan.) 1943.

569. Abozin, V. G.: Early Radiological Diagnosis of Gas Gangrene, abstracted, Bull. War Med. **3**:311 (Feb.) 1943.

570. Muscolo, D.: Ewing Sarcoma and Osteomyelitis: Difficulties of Diagnosis, Rev. Asoc. méd. argent. **57**:599-603 (Aug. 30) 1943.

571. Pinkus, H., and Zlatkin, L.: Tertiary Syphilis of Skin and Bone Co-Existing with Granulomatous Halogen Skin Eruption, J. Michigan M. Soc. **42**:269-273 (April) 1943.

ening of the bone and the periosteum, with circular areas of rarefaction in the regions of increased density. When antisyphilitic therapy was discontinued (as a therapeutic test) the pain and the swelling increased. Roentgenograms showed changes in the tibia, which became irregular, and there was eburnation. When antisyphilitic treatment was again instituted, improvement followed after six weeks, the swelling of the leg subsided and the patient was free of pain.

Weingart, Wirtz and Irving [572] report a case of monilial osteomyelitis in a 10 year old Negro. The patient had been suffering from thrush since the age of 6 weeks. Three weeks prior to admission to the hospital, the child fell, and since that time he had complained of a painful left hip. Except for the granular whitish coating of the mouth and pharynx, examinations, including roentgenographic studies, revealed no abnormalities. The patient was treated by rest in bed and traction. At the end of three months a roentgenogram of the hip showed slight rarefaction of the head and neck of the femur with no acetabular involvement. A Mantoux tuberculin test gave negative results. A hip spica was applied. After two months, the outer aspect of the thigh showed fluctuant swelling. A roentgenogram showed further rarefaction of the head and neck. Pus aspirated from the abscess showed Monilia albicans. The same organism was dominant in the mouth.

Rankin and Eger [573] report a case of acute osteomyelitis in a 14 year old boy whose blood culture revealed staphylococci. There was a history of trauma one week prior to admission to the hospital. There were extreme tenderness and slight swelling on the anterolateral aspect, near the epiphysis, of the lower third of the right thigh. Roentgenograms taken on the third and the thirteenth day after the onset revealed no abnormality. The patient was treated by hot packs, immobilization and blood transfusion. He received sulfathiazole. On the fourteenth day the temperature and the pulse were normal. On the eighteenth day administration of the drug was discontinued. On the twenty-fourth day the patient was discharged ambulatory. A roentgenogram taken three months after the onset appeared normal, and the patient was well. [ED. NOTE.—Without any roentgenographic evidence of change in bone one wonders whether this case should be classed as one of osteomyelitis.]

Flynn [574] reports 100 cases of acute suppurative tenosynovitis of the hand, of which the results were bad in 47 per cent and good in only 33 per cent. In comparison with results reported thirty years previously, Flynn's results showed no improvement. He discusses anatomic and bacteriologic considerations in connection with treatment. In no case of this series did infection come from the blood stream or the lymphatic system. The most important single factor in the production of poor results was delay in operation. Incisions should be adequate to drain every pocket of pus, with care being exercised to avoid injury to the adjacent structures and herniation of the tendon. It is important to observe a strict aseptic technic and to avoid mixed infections. Sulfonamide drugs used locally and systemically seem to minimize the incidence of severe complications. Patients should be hospitalized until the infection has subsided.

Kernwein and Capps [575] briefly review the literature and report on a 24 year old white woman in whom typhoid due to osteomyelitis of the ulna developed three months after she had had typhoid, which was treated with sulfaguanidine. The local lesion in the ulna was excised, packed with sulfathiazole and closed without drainage. The wound healed per primam. Cultures of the excised marrow revealed typhoid bacilli. The microscopic observations are described. The authors discuss draining sinuses of osteomyelitis due to typhoid as a source of contagion, which contraindicates the Orr method of treatment. They suggest that surgical excision, local application of sulfonamide drugs and closure without drainage are beneficial. [ED. NOTE.—This is an interesting observation, and while osteomyelitis due to typhoid is rare the danger of the purulent material's being a source of contagion should be recognized.]

Impink, Denhoff and VanderVeer [576] report a case of hemolytic Staph. aureus septicemia with osteomyelitis of the femur, pericarditis, pneumonia and pleurisy in a 4 year old child who recovered with no recurrence in eight months.

572. Weingart, J. S.; Wirtz, D. C., and Irving, N. W.: Monilia Osteomyelitis: Report of Case Resulting from Thrush, Am. J. Clin. Path. **12**:597-600 (Dec.) 1942.

573. Rankin, L. M., and Eger, S. A.: Acute Hematogenous Staphylococcic Osteomyelitis of Femur: Successful Treatment with Sulfathiazole Without Operation, Am. J. Surg. **59**:136-137 (Jan.) 1943.

574. Flynn, J. E.: Acute Suppurative Tenosynovitis of Hand, Surg., Gynec. & Obst. **76**:227-235 (Feb.) 1943.

575. Kernwein, G. A., and Capps, R. B.: Typhoid Osteomyelitis: Case Report, Am. J. Surg. **60**:433-437 (June) 1943.

576. Impink, R. R.; Denhoff, E., and VanderVeer, J. B.: Staphylococcus Aureus Septicemia, with Osteomyelitis, Pneumonia and Acute Purulent Pericarditis: Case Report, Am. Heart J. **26**:699-708 (Nov.) 1943.

The treatment consisted of: supportive measures, frequent blood and plasma transfusions and administration of sulfathiazole and sulfadiazine and of bacteriophage temporarily. Incision and drainage of the femoral abscess on the eleventh day after the onset were followed by immobilization in plaster with the Orr treatment for eleven weeks. Repeated aspiration of the pericardial sac, pericardiostomy and thoracentesis were done. Laboratory studies showed positive blood cultures until the ninth day and negative cultures of pericardial fluid until pericardiostomy, and roentgenograms of the femur revealed no abnormality until the eleventh day. [ED. NOTE.—This is an adequate study and report except that no roentgenogram of the femur was made later than one month after the patient's discharge from the hospital.]

Wilensky [577] reports a case of osteomyelitis of the tibia with thrombosis of the saphenous vein. He emphasizes the importance of treating bacteremia and toxemia primarily and withholding operation on the bone itself. Treatment consisted of excision of the thrombophlebitic vein to remove the main source of bacteremia. Sulfonamide compounds were given systemically. The author draws a parallel between this case and an instance of acute mastoiditis complicated by thrombosis of the internal jugular vein. Both instances indicate the importance of vascular thrombosis in the pathogenesis of foci in bone. The author believes that in most cases the extent of the focus in the bone is almost immediately determined by the character and position of the embolic thrombophlebitis, and what appears in the roentgenogram to be a spread is an increase in the amount of temporary decalcification of the diseased area. [ED. NOTE.—Wilensky's views on the treatment of acute osteomyelitis still seem too conservative to warrant their routine adoption. He draws an interesting parallel in discussing the pathogenesis of the infection of bone.]

Kanan [578] presents 3 cases of acute osteomyelitis of the tibia in which subperiosteal resection was the treatment employed. In all of these cases and in another in which roentgenograms could not be obtained the tibia healed under optimal conditions, with abundant regeneration of bone of good quality. The general condition improved shortly after the operation. Indications and contraindications must be considered in each individual case. Subperiosteal resection is recommended for localized forms of acute osteomyelitis the course of which indicates a tendency to heal. [ED. NOTE.—Only in certain localities in the body would resection of the infected bone seem justifiable.]

Franz [579] reviews the work of Vidal on gunshot injuries of the joints in the Spanish Civil War (1,282 wounds). They were treated by drainage and immobilization alone. Good results were obtained in a majority of the patients, which suggest that resection of a joint for purposes of drainage is unnecessary. For the more extensive lesions the prognosis was not so good. Of 273 patients with gross damage near a joint, 10.2 per cent died. For 103 patients with suppuration of a joint there was a mortality rate of 26.4 per cent. He concludes that in cases of fulminating infection amputation is the only possible treatment; resection is useless. Franz favors resection and believes that the danger of infecting the bone at the site of resection has been greatly exaggerated. The causes of death after resection include poor selection of cases, insufficient preparation, delay of operation until infection has become generalized and performance of an operation on patients who are not in a fit state to spend a long time in bed.

Bugyi [580] states that primary infections leading to bacteremia precede clinical manifestations by a few days. The patient is not in a severe septic condition due to osteomyelitis but has acquired osteomyelitis from sepsis. With this point of view, it is logical to combat sepsis first. Beside intravenous administration of resorcinol, quinine, sulfonamide compounds, and saline and dextrose solution, local therapy is of little significance. Immobilization, elevation of the extremity and induction of hyperemia are recommended. Persistent fever and severe leukocytosis should not mislead the operator to premature surgical operation. Expectant treatment is indicated. A "fixation" abscess is awaited.

Experience is needed to choose the proper moment for surgical intervention, which must be neither too early nor too late. Subperiosteal resection is contraindicated in severe acute infections. For subacute or chronic infections this procedure may be used, but only in exceptional cases, in which the periosteum is completely

577. Wilensky, A. O.: Osteomyelitis of Tibia with Thrombosis of Saphenous Vein: Discussion of Conservative Therapy, Pennsylvania M. J. **46**:953-955 (June) 1943.

578. Kanan, E. J.: Subperiosteal Resection in Therapy of Acute Osteomyelitis, Arq. rio grand. med. **20**:165-180 (Oct.) 1942.

579. Franz, C.: Resection of Infected Joints, abstracted, Bull. War Med. **3**:322-324 (Feb.) 1943.

580. Bugyi, I.: Conservative Therapy of Acute Osteomyelitis of Long Bones, Chirurg **14**:742-745 (Dec.) 1943.

detached and the long bones surrounded with pus. [ED. NOTE.—This is a good article.]

Gellman [581] reports a case in which an extra-articular focus irritated the hip joint by juxtaposition, with resulting early diagnostic confusion. The patient, a 3 year old Negro girl who had been suffering from an infection of the upper respiratory tract with some abdominal pain noticed pain in her left hip two weeks later. Examination three weeks after the onset of illness, including the taking of roentgenograms, gave negative results except for an injected pharynx. The impression was pharyngitis with possible rheumatic disease. One week later the patient complained of burning on urination. The left thigh was adducted and the knee flexed. The temperature was 102 F. There were a few pus cells in the urine. A roentgenogram of the hip revealed no abnormality. The diagnosis of possible tuberculosis of the hip was made, and the patient was put in traction. There were rigidity in the left lower quadrant of the abdomen and fulness below the left inguinal ligament. The white blood cell count was 34,000. The tuberculin test with a 1:1,000 dilution gave positive results. A culture of the urine showed Staph. albus, but the temperature remained elevated. A diagnosis of pyelitis was made, and all tests of fluid apirated from the hip gave negative results. Two weeks later, while the swelling above and below the ligament, which had been increasing, was being examined, the patient suddenly winced and urinated frank pus. The bladder had been perforated. Incision and drainage of the mass were performed, and similar pus was released. A culture showed Staph. albus. Cystograms confirmed the diagnosis of extravesicular abscess. The patient recovered uneventfully. [ED. NOTE. —This is an instructive report of an unusual site for an abscess.]

Abeshouse and Gellman [582] discuss the pathogenesis, pathologic changes, clinical features, diagnosis and treatment of various complications of the bladder due to injuries and diseases of the pelvic girdle. A review of the literature and personal experiences with 4 cases of pelvifemoral osteomyelitis with involvement of the bladder are recorded. The authors conclude:

1. Infections of the urinary tract, particularly of the bladder, are relatively rare complications of injuries and diseases of the pelvic girdle. 2. Infection of the urinary tract complicating injuries or diseases of the pelvic girdle may be due to (*a*) an infection antedating the osseous lesion, (*b*) an infection occurring simultaneously and by the same organisms causing the osseous lesion, (*c*) a subsequent infection resulting from the hematogenous transportation of organisms from the osseous lesion, and (*d*) the direct extension of the infectious process from the osseous lesion to an adjacent portion of the urinary tract. 3. The latter type of infection (*2d*) usually manifests itself as an infectious process in or about the bladder. The bladder complications include intravesical infection (cystitis), perivesical infection (para-osseous abscess, perivesical phlegmon, acute or chronic pericystitis), intramural infection (abscess of the bladder wall), intraperitoneal or extraperitoneal rupture of the bladder, osteovesical, osteocutaneo-vesical, or cutaneo-vesical fistula, calculus formation, and perforation of the bladder by fragments of bone sequestra or involucra. 4. In cases of pelvifemoral osteomyelitis, there are two characteristic signs of bladder involvement which can be readily determined by cystographic study, viz.: lateral displacement of the bladder and alterations in the outline of the bladder. 5. These bladder changes may be produced by several different lesions which originate in the osseous lesion and extend to the perivesical tissues in the bladder wall, viz.: (*a*) para-osseous abscess in the perivesical tissues; (*b*) an involucrum or sequestrum in the perivesical tissues and pressing on the bladder; (*c*) acute or chronic pericystitis resulting from the extension of the infectious process from the osseous lesion to the perivesical tissues; and (*d*) intramural abscess of the bladder secondary to the osseous lesion or perivesical abscess. 6. These lesions may lead to the development of an osteo-vesical fistula with or without the subsequent formation of calculi in the bladder. These lesions may also be responsible for secondary obstructive or infectious changes in the upper urinary tract as a result of an acute or chronic infectious or cicatricial process about the base of the bladder and the lower ureters. 7. Prompt surgical treatment is indicated in these cases in order to prevent or forestall the development of an osteovesical fistula or serious damage to the upper urinary tract. 8. Conservative treatment consisting of chemotherapy and supportive therapy has yielded good results in unrecognized or undiagnosed cases of para-osseous abscesses but this type of treatment is not advisable in the accurately diagnosed case for the reasons indicated above.

Lenormant [583] emphasizes the fact that treatment with sulfonamide drugs is only a supplement to the usual surgical procedures and not a substitute for them. He used sulfanilamide. At each operation and each dressing of the wound, this drug was applied locally in the form of a powder or crystals. After the wound had been closed by suture, administration of the drug was continued by mouth. In 19 cases wounds were treated; in 16 cases they were war wounds. In 1 the lesion was due to fracture of the leg which had occurred three years previously, and in 1 it followed a fracture of the pelvis; in the last case the wounds were due to osteomyelitis

581. Gellman, M.: Perforation of Bladder by Non-osseous Retroperitoneal Abscess: Report of Case, Bull. School M. Univ. Maryland **27**:90-95 (Oct.) 1942.

582. Abeshouse, B. S., and Gellman, M.: Bladder Complications of Injuries and Diseases of Pelvic Bones and Head of Femur, Urol. & Cutan. Rev. **47**:88-105 (Feb.) 1943.

583. Lenormant, C.: Sulphonamides in Treatment of Traumatic Osteitis with Fistulae, Bull. War Med. **3**:265 (Jan.) 1943.

of the humerus, radius and ulna in a child of 6 years. Most of the lesions showed profuse suppuration and sequestration. With this treatment the results of operation were much improved. Postoperatively suppuration was slight or absent and there was no important febrile reaction. Granulation tissue appeared more healthy. All but 1 wound were completely healed on the patient's discharge from the hospital, one to two and a half months after operation. Eleven patients were followed for five to eight months, and there were no recurrences. Sulfonamide compounds do not promote ossification of fractures bridged by fibrous tissue, but they do permit further operation to produce bony union even in the presence of primary infection. In 3 cases a small infected cavity was opened in the bone, cleaned out and powdered with sulfonamide drugs and the wound closed by primary suture. The results were good. [ED. NOTE.—This is a good article, but the follow-up period is entirely too brief for conclusions to be drawn.]

In 2 cases Lenormant and Calvet [584] treated chronic staphylococcic abscess of bone by evacuation of pus, local application of a sulfonamide drug and primary suture. Fistulas developed in both cases, and the wounds had to be reopened. In 3 other cases the infection responded moderately well to operation, local application of a sulfonamide drug and drainage of the site together with administration of a sulfonamide compound by mouth. The results were definitely less favorable than those in streptococcic infections. Lenormant then tried simultaneous administration of large doses of an iodide preparation and a sulfonamide drug. In anthrax the results were good; cure was rapid without surgical intervention. Calvet treated 8 children with acute osteomyelitis with an iodide solution and sulfanilamide given by mouth. Only puncture and incision of the abscess were done. The response was dramatic, with relief of pain and pyrexia in two to eight days. The course of healing was followed by roentgenographic study, all but 1 patient being followed for from five to nine months. All remained cured. This treatment should be started as early as possible, before suppuration and necrosis have invaded the bony tissue. It was not considered sufficient for subacute osteomyelitis with pyemia. [ED. NOTE.—Good results with the proper use of sulfonamide drugs are now common experience. The advantage of giving iodides is open to question.]

584. Lenormant, C., and Calvet, J.: Sulphonamides in Treatment of Staphylococcal Osteitis, Bull. War Med. **3**:265 (Jan.) 1943.

Angevine [585] observes that sulfanilamide, sulfathiazole, sulfadiazine and sulfapyridine can be suspended in oil in high concentrations. Suspensions of sulfanilamide and of sulfathiazole in soybean oil produced only a slight local reaction when injected subcutaneously into experimental animals.

A single subcutaneous injection was absorbed at a uniform rate and produced a concentration of the drug in the blood for as long as eight days, depending on the dose. Excretion of the drug in the urine continued for several days after it had disappeared from the blood. Suspensions of sulfanilamide or sulfathiazole in soybean oil were instilled into the infected sinus tracts of 5 patients with osteomyelitis. The drug was present in their blood for six days and was excreted for as long as one hundred and thirty-seven days. The sinuses of 2 of these patients are entirely healed, and the others are improved. The author feels that this therapeutic method deserves further trial in chronic osteomyelitis and in other wounds. [ED. NOTE.—It is to be hoped that further work along this line may be done.]

For the past four years, Lewis and Senter [586] have used sulfonamide drugs as an adjunct in the treatment of acute and chronic osteomyelitis. Sulfathiazole was used most frequently and was used locally and orally. After saucerization and curettement, the wound was packed with 4 to 8 Gm. of the drug and petrolatum gauze. In cases in which the infection was acute, the administration of large doses of sulfathiazole was begun on diagnosis and continued postoperatively until the acute infection had subsided. The dose was 6 Gm. daily for adults and 0.09 to 0.13 Gm. (1.5 to 2 grains) per pound of body weight (0.045 to 0.065 Gm. per kilogram) for children. In cases in which the infection was chronic, 3 to 4 Gm. given by mouth daily for adults and 0.06 to 0.09 Gm. (1 to 1.5 grains) per pound of body weight (0.03 to 0.045 Gm. per kilogram) for children were advised for a few days following operation. Early active motion is used after a preliminary postoperative period of immobilization. The authors review 307 cases observed from 1925 to 1942. They conclude that sulfonamide drugs are of definite value with surgical treatment in acute osteomyelitis. They are of little value for chronic infections except in has-

585. Angevine, D. M.: Absorption and Excretion of Sulfonamide Compounds Suspended in Oil: Observations on Animals and on Patients with Chronic Osteomyelitis, War Med. **3**:186-193 (Feb.) 1943.

586. Lewis, J. R., Jr., and Senter, W. J.: Osteomyelitis, J. M. A. Georgia **32**:302-306 (Sept.) 1943.

tening remission of acute exacerbations and in preventing exacerbations following operation.

A number of patients with osteomyelitis were treated conservatively by James,[587] with good results. Treatment consisted of rest, application of heat and administration of sulfathiazole. For toxic conditions blood transfusions are of value. Early control of the bacteremia limits the development of foci. Abscesses may disappear without being opened, and secondary infection may thus be avoided. Sequestrums are rendered aseptic and are absorbed or reconstituted into healthy bone. Convalescence is shortened, and no deformities or scars result. The author feels that plaster casts should not be used in this disease. [ED. NOTE.—This is a rather overoptimistic report on a disease that is notoriously difficult.]

Pascau Perez [588] reviews 300 cases of hematogenous osteomyelitis and presents analytic data on the site of involvement: The lower extremity was involved in 81 per cent of the cases, the upper extremity in 17.34 per cent and the trunk in 1.66 per cent. The tibia was involved in 122 cases, the femur in 88 and the humerus in 29. In 110 cases there was a history of definite trauma; this preceded the first symptoms by from three to twenty-four days. In 25 of the cases in which there was a history of trauma the patients were convalescing from various infectious diseases. The hypertoxic form occurred in 2.66 per cent of the cases, the acute form in 43 per cent, the chronic form in 48.66 per cent, the sclerosing type of Garré in 3 per cent and Brodie's abscess in 2.66 per cent. In 65 of the 129 cases of acute infection the patients were treated with simple incision of the subperiosteal abscess and immobilization. Slowly developing osteomyelitis was treated with sulfanilamide, incision and immobilization by means of holes drilled in the metaphysis. For serious involvement of bone the treatment consisted of ample opening, grooving the bone, removing sequestrums, packing the cavity with petrolatum gauze and immobilization. Cure was obtained in 245 of the 300 cases, or 81.66 per cent; in 43 cases the final result was not yet established. Amputation was necessary in 8 cases, and in 4, or 1.3 per cent, the patients died. Of the 245 cases in which cure was effected, there was no deformity or restriction of function in 29.66 per cent. In 42 per cent there was slight thickening of bone; in 10 per cent there were evident thickening, some shortening and some limitation of function; in a few some degree of ankylosis was present. Three of the patients on whom amputation was performed had had osteomyelitis for more than thirty years. In 1 case a malignant growth sprang from the osteomyelitic focus. [ED. NOTE.—The large series and the analytic data presented in this article make it important.]

Dennis [589] notes that with the Orr method and with expectant treatment for chronic osteomyelitis 25 per cent of the patients showed healing with cessation of drainage. Many patients returned with exacerbations months and years after apparent healing. Roentgenograms showed areas of rarefaction, which were suggestive of abscess of bone, and areas of irregularity and sclerosis. These pictures imply quiescence and not a true return to normal structure and function. Treatment by prolonged dependent drainage with rigid tubes was instituted in 12 cases. Various materials were tried experimentally, and lucite (polymerized methyl methacrylate) was found to be least irritating. It softens in boiling water and can be molded. The tubes were 7 mm. in internal diameter, and they were sterilized by aqueous solution of metaphen. The tibia lends itself best to placement of the drains. The abscess cavity is opened and packed with dry gauze, which is removed after a few days. An anterior hole to accommodate the drain is drilled from below into the cavity. This permits drainage when the patient is erect. Another is drilled from the posterior aspect at right angles to the skin to allow drainage when the patient is supine. The tubes are held in place by wire. A cast is applied; two weeks later this is removed, and the patient is allowed full activity. Daily irrigations with buffered aqueous solution of sodium hypochlorite are used. Six of the patients were reported cured in two to eighteen months, 4 were still under treatment after six to twelve months and there were two failures. One failure occurred in an obese patient with osteomyelitis of the humerus in whom drains could not be held in place. The other occurred in a patient with osteomyelitis of the femur with extensive necrosis; after placement of the drains, there was relief of discomfort and ache, and no ill effect

587. James, E. S.: Conservative Treatment of Acute Osteomyelitis, Manitoba M. Rev. **23**:314-315 (Dec.) 1943.

588. Pascau Perez, I.: Therapy of Hematogenous Osteomyelitis: Critical Study Based on Three Hundred Cases, Cir. ortop. y traumatol., Habana **10**:81-110 (April-June) 1942.

589. Dennis, C.: Prolonged Dependent Drainage with "Lucite" Drains in Treatment of Chronic Osteomyelitis, Surgery **13**:900-910 (June) 1943.

was noted when normal activity was permitted. Dennis feels that this method of therapy is best adapted to superficial long bones, where saucerization, application of sulfathiazole and primary closure are most difficult because of inadequate soft tissue for obliteration of the dead space. The author also believes that prolonged dependent drainage best restores normal bony architecture, as shown by roentgenograms.

Miley [590] reports a case of hemolytic Staph. aureus septicemia in which rather striking results followed ultraviolet blood irradiation, with the Knott technic. In brief, this consists in withdrawing a certain amount of the patient's blood, exposing it to high intensity ultraviolet rays and immediately reinjecting it into the patient. The author mentions that he previously reported on 7 patients who received no benefit from this therapy but that he feels that this case shows what can be accomplished by the Knott technic. He also expresses the opinion that therapy should be instituted early and whole blood transfusions used as needed but warns against the use of any sulfonamide drugs if ultraviolet irradiation of the blood is employed. [ED. NOTE.—I feel that this method has little to recommend it in comparison with the excellent results obtained today with the use of penicillin.]

In connection with the surgical treatment of osteomyelitis due to a penetrating wound, Perkins [591] takes the opportunity of illustrating the sequelae of a compound fracture. He cites these as follows: The inflammation may subside, acute osteomyelitis may develop, a sinus may develop or the wound may stay quiescent for years but ultimately flare up. In short, he states that there is no surgical treatment for persistent acute inflammation of the bone and makes the amazing statement that "in persistent acute osteomyelitis amputation of the limb is therefore often advisable, either to save life or because an artificial limb will be of more use to the patient than his own crippled leg." If persistent osteomyelitis is caused by loose bone or a foreign body, its removal may permit closure of the wound. Roentgenographic evidence here is of great help but is not decisive. He states that exacerbations are the most difficult to treat and that treatment should consist of rest and hot applications to the part. No surgical operation is recommended unless an abscess forms; when this occurs the abscess should simply be opened. [ED. NOTE.—Amputation has little place in the treatment of acute osteomyelitis. Unnecessary surgical treatment jeopardizes the patient's life. In the acute stage it is impossible to evaluate the final status of the extremity.]

Wilkinson [592] reports on 40 patients with acute hematogenous osteomyelitis due to staphylococci who were treated in 1940 and 1941. On admission to the hospital the patient is put to bed and given sedatives, fluids, dextrose or saline solution intravenously if necessary and transfusions if necessary. One and one-half to 2 grains (0.09 to 0.13 Gm.) of sulfathiazole per pound of body weight (0.045 to 0.065 Gm. per kilogram) is given daily. The first dose, given on admission, is one half of the calculated daily dose. If oral administration is impossible, sodium sulfathiazole is given intravenously in the same dose. Surgical intervention is contraindicated until measures have been taken to combat septicemia. When there is reasonable certainty that pus is present, operation is done if the general condition is satisfactory and the blood sulfathiazole level is 5 mg. per hundred cubic centimeters or more. These conditions are usually fulfilled within twenty-four hours. Incision over the affected bone, with the patient under general anesthesia and without a tourniquet, was advised, with division of the periosteum, evacuation of pus and the making of two drill holes into the metaphysis. The author packs the wound loosely with gauze soaked in acriflavine in glycerin or some other greasy material, applies a dressing and places the extremity in plaster or traction. The packing is removed at the end of a month and not replaced. The dose of sulfathiazole was cut at the end of the first week and continued for at least four weeks. The author reported 2 deaths; in 8 of the 38 surviving patients the wounds failed to heal.

Wilson and McKeever [593] report on 31 patients with acute osteomyelitis, of whom 20 were boys and 11 girls. None was over 13 years of age. All of the patients were febrile, toxic and dehydrated, and for all the initial roentgenograms revealed no abnormality. In 30 of the patients

590. Miley, G.: Disappearance of Hemolytic Staphylococcus Aureus Septicemia Following Ultraviolet Blood Irradiation Therapy: Knott Technic, Am. J. Surg. **62**: 241-245 (Nov.) 1943.

591. Perkins, G.: Surgical Treatment of Osteomyelitis Due to Penetrating Wound, Brit. M. J. **1**:441-442 (April 10) 1943.

592. Wilkinson, F. R.: Treatment of Osteomyelitis, Tr. Roy. Med.-Chir. Soc. Glasgow, 1942-1943, pp. 2-5; in Glasgow M. J., December 1942.

593. Wilson, J. C., and McKeever, F. M.: Role of Sulfonamide Drugs in Treatment of Hematogenous Osteomyelitis, J. Bone & Joint Surg. **25**:41-48 (Jan.) 1943.

the onset had occurred five to seven days before admission to the hospital. In 28 of the patients the infection was caused by Staph. aureus haemolyticus, and in 20 of these the organism was recovered from the blood stream. Sulfathiazole was used; in 21 patients an average dose of 4.6 Gm. was given for eleven and seven-tenths days. For 6 patients, sulfapyridine was used for ten days. Sulfanilamide was used for 2, and several received both sulfanilamide and sulfapyridine. Blood transfusions were employed when indicated. In 27 of the patients, all of whom had abscesses, the drug therapy was supplemented by surgical operation. Twenty-three had conservative surgical operation directed at both the soft tissues and the bone; on 4 the operation involved the soft tissues only. The patients showed rapid improvement; 16 of the 20 patients whose blood culture was positive had a culture a week later which was negative. The effect of the drug on the fever was inconstant; in about one half of the patients studied, the temperature did not reach and maintain a normal level until the abscess had been drained. Erythema nodosum developed in 3 patients and jaundice in 1. There was 1 death, giving a mortality of 3.2 per cent, while in the same hospital prior to the use of sulfonamide drugs the mortality had been 12.7 per cent. In 20 of the patients who were examined some months later all the sinuses were healed. There was good reconstruction of the affected bone, with no evidence of central abscess and no impairment of function of joints.

Wilensky [594] points out that the treatment of acute hematogenous osteomyelitis is concerned with three factors: (1) the general infection, (2) the lesion of the bone and (3) the presence of other metastatic lesions. At an early period in the development of the focus in the bone, the bacteremia is due to a primary lesion elsewhere; this is confirmed by the spontaneous disappearance of the bacteremia within a few days. At a later period both the primary lesion and the osseous lesion may be responsible for a positive blood culture. When progressive diminution in the number of colonies ceases and a few colonies persist in spite of chemotherapy, the probable cause is thrombophlebitis in or about the focus in the bone. Traumatization of the focus, such as operation or manipulation, may cause bacteremia. Treatment of the various degrees of infection may be grouped as follows: 1. For mild infection with slight clinical symptoms and blood cultures which yield ten to thirty colonies per cubic centimeter, the drug selected should be given in a dosage commensurate with the degree of infection. If the blood culture does not become sterile within a short time, the assumption is that there is active thrombophlebitis in the focus. If excision of the focus is impossible, ligation of the main vein draining the involved part must be considered. 2. Severe infection (one hundred or more colonies per cubic centimeter) requires intensive chemotherapy. Here, again, if bacteremia persists one should consider ligation. 3. The most severe infection (innumerable colonies per cubic centimeter) is overwhelming and presumably involves multiple organs; the only possible treatment is chemotherapy. It is stressed that in the early stages, while bacteremia is present, treatment should be conservative, including chemotherapy and transfusions. Three conditions may follow formation of a focus of osteomyelitis: (1) spontaneous resolution, (2) formation of an abscess under the periosteum or in the bone, which may spread to the soft parts, and (3) bony necrosis and sequestration. When there is no generalized infection, operation should be limited to incision and drainage of abscesses only. The pathologic process should be permitted to develop, to retrogress spontaneously or to go on to the stage of necrosis and sequestration uninfluenced by surgical intervention.

Eggers and Knight [595] discuss the treatment of osteomyelitis under the following heads: (1) for traumatic acute infection, complete débridement, irrigation, local application of sulfonamide drugs, primary closure over the bony defect and adequate immobilization; (2) for infected traumatic acute osteomyelitis, adequate surgical drainage, removal of necrotic tissue and either local application of sulfonamide compounds or the Orr treatment; (3) for acute hematic infection, general supportive measures, including systemic administration of sulfonamide drugs and transfusions, drilling of bone and local application of sulfonamide compounds, and later sequestrectomy and saucerization followed by local application of sulfonamide drugs or the Orr treatment; (4) for chronic hematic osteomyelitis, saucerization where indicated followed by local application of sulfonamide drugs or the Orr method; (5) after active infection of bone subsides, skin

594. Wilensky, A. O.: Modern Treatment of Acute Hematogenous Osteomyelitis of Long Bones, Connecticut M. J. **7**:26-29 (Jan.) 1943.

595. Eggers, G. W. N., and Knight, M. D.: Treatment of Osteomyelitis, Texas State J. Med. **39**:297-301 (Sept.) 1943.

grafting by the sliding, split graft or the pedicle full thickness technic. The authors conclude that for chronic infection local treatment with sulfonamide drugs is as effective as a combination of local and systemic therapy. They found the results of the Orr method and those of treatment with sulfonamide drugs about the same but preferred the latter. Of 366 patients about 83 per cent were well for at least three years. [Ed. Note.—I should consider 83 a good percentage.]

McKeown [596] reviews 100 cases of acute osteomyelitis and emphasizes the 26 in which sulfathiazole was used. He gave the drug in a dosage of 1 Gm. per 20 pounds (9 Kg.) of body weight per day for eight days and repeated this after an interval of three weeks. In 17 cases also the metaphysis was drilled by the sixth day and a cast applied. In 9 cases varied treatment with minimal surgical treatment was given. The best results were obtained with sulfathiazole treatment. The author concluded that sulfathiazole is most beneficial for early acute osteomyelitis, in a dosage calculated to produce a blood level of not over 6 mg. per hundred cubic centimeters. There is some evidence that albuminuria occurs less often when the urine is acid and can be avoided by giving 100 mg. of nicotinic acid daily with higher doses of sulfathiazole. Drilling of bone gave better results than any other surgical procedure and was most effective when done early in the disease and when combined with an adequate dose of sulfathiazole. No definite permanent improvement was obtained from the use of sulfathiazole in chronic osteomyelitis. Sulfathiazole seemed to reduce the duration of the disease.

Robertson [597] reports 89 cases of osteomyelitis, in 90 per cent of which staphylococci were the cause; the treatment consisted of administration of large doses of sulfonamide drugs. The average dose for an 8 year old child was 8 to 10 Gm. daily, which produced a blood level of 6 to 12 mg. per hundred cubic centimeters. He noted great individual variation in the blood level with large doses. In about 8 per cent of the cases reactions required discontinuance of the drug or changing from sulfathiazole to sulfadiazine. The author advises high initial doses. Sulfonamide drugs do not inhibit the formation of antitoxin. No surgical operation was done in about 30 per cent of the cases of this series; in the 1 case in which incision was resorted to early death resulted. Sequestration occurred in only 10 to 15 per cent of the cases. Traction was the only form of immobilization used, and that was used only when a joint also was involved. The mortality rate was 4.2 per cent. [Ed. Note.—No information is given as to when administration of sulfonamide drugs was started in relation to the onset of the disease. The author states that incisional interference is not a factor in saving lives, but its use for late abscesses in about 70 per cent of his cases indicates its value in improving local lesions.]

Alexandrov [598] describes the treatment for chronic osteomyelitis after gunshot injuries. The article is based on a study of 858 cases in the Soviet Union. Auxiliary treatment includes balneotherapy, physical therapy, climatotherapy and the use of diets, vitamins, physical culture and medicine. The most important balneologic factors include various muds, clays and sulfide baths. The chief climatic agent is sunlight. The action of resin, radon, carbon dioxide and thermal baths as well as of naphthalene and koumiss is being investigated. The author thinks that spa treatments should be used also in hospitals. Indications and contraindications for the various treatments are discussed. Often spa treatment needs to be continued for forty-five to sixty days. A table shows the results obtained by various Russian physicians who use spa treatment. [Ed. Note.—This interesting method is based on a large number of cases; a report on the roentgenographic changes following the spa treatment would be of value.]

Toumey [599] reports that at the Lahey Clinic 13 patients who had either chronic osteomyelitis with formation of a sinus or acute reactivation of previous osteomyelitis were treated with sulfathiazole and rest in bed for one week before operation, 90 grains (5.8 Gm.) of the drug being given every twenty-four hours. The operation consisted of saucerization, putting 2 to 15 Gm. of sulfathiazole in the wound, closure without drainage and plaster immobilization. Sulfathiazole was given orally for at least two weeks postoperatively. No saucerization was done in cases of actively draining sinuses without extensive infection of bone. All wounds healed promptly except 2 in patients who did not tolerate sulfathiazole. Sulfathiazole therapy without operation was ineffective.

596. McKeown, K. C.: Role of Chemotherapy in Treatment of Haematogenous Osteomyelitis, Brit. J. Surg. **31**:13-22 (July) 1943.

597. Robertson, D. E.: Medical Treatment of Hematogenous Osteomyelitis, Ann. Surg. **118**:318-328 (Aug.) 1943.

598. Alexandrov, V. A.: Spa Treatment of Chronic Osteomyelitis After Gunshot Injuries of Bone, Brit. J. Phys. Med. **6**:130-132 (Sept.-Oct.) 1943.

599. Toumey, J. W.: Sulfathiazole in Chronic Osteomyelitis, Surgery **14**:531-540 (Oct.) 1943.

In the treatment of compound fractures infected with Staph. pyogenes, Heggie and Kendall [600] prefer sulfathiazole to sulfadiazine because it is ten times as bacteriostatic and is better tolerated. Four cases are described to show that chemotherapy before and after operation is essential and should be supplemented by local application at the time of surgical treatment. Sulfathiazole applied locally proves ineffective unless supported by oral administration, and even slight or moderate infection requires repeated application. No staphylococci were found to be resistant to sulfonamide drugs.

Truog [601] points out that a definite roentgenologic diagnosis of lesions of bone due to acquired syphilis is difficult because of their varied manifestations. Believing that all syphilitic lesions of bone should be termed syphilitic osteomyelitis, the author presents 9 cases with eight roentgenograms to show the osteomyelitic nature of acquired syphilis of bone. A correct diagnosis can be made if differential roentgenographic criteria are studied carefully.

Kleiger and Blair [602] feel that some strains of staphylococci produce a potent exotoxin which when injected intravenously into laboratory animals causes convulsions and death; toxigenic staphylococci when injected intravenously into laboratory animals are capable of producing the exotoxin and causing death. Susceptible patients who are infected by toxigenic staphylococci suffer from abdominal pain, diarrhea, incontinence, meningismus, coma and delirium with a rapid rise in pulse rate and temperature. In such cases a potent specific antitoxin has proved effective, its dosage being adjusted to the size of the patient and to the degree of toxicity. Between 1,000 and 2,000 units of antitoxin per pound of body weight (between 2,200 and 4,400 units per kilogram) is given on the first day, with smaller doses thereafter. It is emphasized that the antitoxin is effective only in true staphylococcic toxemia in young patients. The authors describe a routine for minimizing serum reactions.

McClean, Rogers, Williams and Hale,[603] in studying gas infections in laboratory animals, sought to determine how early bacterial enzymes can be detected in edema fluid or exudate from a wound. If the strain was capable of producing hyaluronidase, the enzyme could be detected in the edema fluid as soon as enough fluid could be obtained for examination and in muscle at the earliest sign of infection. Lecithinase was detected at a similar stage in Cl. welchii infections. Most strains of Cl. welchii associated with gas gangrene and all strains of Clostridium septicum produced hyaluronidase, but less than half of the strains of Clostridium oedematiens produced it. The authors describe methods for the detection of hyaluronidase and lecithinase. Emphasis is placed on the fact that these experiments were made with pure cultures whereas infections of wounds are usually mixed.

L'Episcopo and Hagerty [604] present a series of 27 patients with acute hematogenous osteomyelitis who were treated by rest in bed, traction, massive hot wet packs, correction of dehydration, multiple blood transfusions, oral administration of sulfonamide drugs and aspirations. Four patients required delayed incision and drainage of the soft tissues; in 5 others sinuses developed, while 18 had no scars, sinuses, operations, deformity or disability of any kind. Sulfanilamide was used for streptococcic infections and sulfathiazole for staphylococcic infections. The authors consider this treatment adequate except in cases in which a joint is threatened or in which aspirations do not control the abscess.

Solomon and Bachman [605] show that in pyogenic osteomyelitis of the spine the lesion may remain unrecognized because respiratory symptoms mask the spinal symptoms. Roentgenograms show one of the early signs to be narrowing of the intervertebral space due to destruction of the disk. Any patient who has a high temperature, rigidity and fixation of the muscles of the back, pain over the spine and roentgenographic evidence of mediastinitis must be suspected of having osteomyelitis of the spine. The authors present an illustrative case.

600. Heggie, J. F.; Kendall, A. W., and Heggie, R. M.: Infected Wounds Involving Bone Treated with Sulphapyridine and Sulphathiazole, Brit. M. J. **2**:655-658 (Dec. 5) 1942.

601. Truog, C. P.: Bone Lesions in Acquired Syphilis, Radiology **40**:1-9 (Jan.) 1943.

602. Kleiger, B., and Blair, J. E.: Role of Toxin and Use of Antitoxin in Systemic Staphylococcic Infections, Arch. Surg. **46**:548-554 (April) 1943.

603. McClean, D.; Rogers, H. J.; Williams, B. W., and Hale, C. W.: Early Diagnosis of Wound Infection with Special Reference to Gas Gangrene, Lancet **1**: 355-360 (March 20) 1943.

604. L'Episcopo, J. B., and Hagerty, E. D.: Conservative Management of Acute Osteomyelitis, New York State J. Med. **43**:853-856 (May 1) 1943.

605. Solomon, H. A., and Bachman, A. L.: Pyogenic Osteomyelitis of Thoracic Spine Presenting as Primary Pulmonary Disease, Am. J. Roentgenol. **49**: 219-226 (Feb.) 1943.

A REVIEW OF UROLOGIC SURGERY

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URETER

Anomalies.—Andrews and Vernon [30] state that ectopic ureter usually occurs in females. In women this anomaly leads to incontinence of part of the urine and normal vesical control of the remainder. In men the opening of the aberrant ureter is above the external sphincter and incontinence of urine does not occur. The most common site of an opening of an ectopic ureter in the female is in the vestibule near the external meatus. This is readily understandable when it is remembered that this structure, like the ureter, develops from the wolffian ducts. The vagina develops from the müllerian ducts, and a true ectopic vaginal ureter is rare. The vaginal opening of an ectopic ureter is nearly always situated on the anterior wall near the midline, but when the opening is near the cervix it tends to become more lateral. Only 5 cases in which an ectopic ureter opened near the cervix in the lateral fornix have been found, after an exhaustive search of the literature.

Andrews and Vernon report a case in which a girl, aged 12 years, had incontinence of urine but passed urine naturally and appeared to have vesical control. Cystoscopy revealed two ureteral orifices in the bladder and also an outlet in the vagina. Intravenous pyelograms showed that the kidneys were apparently normal. There also was evidence of a double ureter and an accessory calix above the left kidney. Operation revealed a double kidney. The small accessory pelvis and a portion of the ureter were removed.

Tumor.—Rademaker [31] reports a case of leiomyosarcoma of the ureter. This represents the sixth case of primary sarcoma of the ureter that has been reported in the literature. The chief features of the growth were: It produced relatively few symptoms, there were no obvious metastatic lesions, although the tumor was large, the tumor was well encapsulated and the index of malignancy was low. The difficulties in diagnosis are obvious because of the negative results of laboratory and roentgenologic studies. Removal of the tumor was complicated by violent hemorrhage. Convalescence after operation was uneventful. It is yet too early to discuss the final end result.

McMahon [32] reports 2 cases of tumor of the ureter. In the first case the patient had a simple tumor of the ureter; the site and limit of the tumor were well demonstrated by a ureterogram. In the second case the patient had a bilharzial tumor of the ureter, which was demonstrated by ureterography. It is now being recognized that

30. Andrews, J. A., and Vernon, H. K.: Ectopic Vaginal Ureter, Brit. J. Surg. **31**:195-197 (Oct.) 1943.

31. Rademaker, L.: Primary Sarcoma of the Ureter: Case Report and Review of the Literature, Am. J. Surg. **62**:402-406 (Dec.) 1943.

32. McMahon, S.: Tumors of the Ureter, J. Urol. **51**:616-622 (June) 1944.

bilharziasis is a serious disease. Unfortunately, in the initial stage of the disease, when hematuria is present and ova are found in the urine, the symptoms are mild and the disease often is neglected. In this stage treatment with antimony is indicated. If the disease is neglected or if insufficient treatment is given, sequelae related to the ureters are common. The most frequent ureteral complication is stricture of the intramural portion of the ureter and dilatation of the pelvic portion. Formation of a tumor is rare.

Counseller, Cook and Seefeld [33] consider primary epithelioma of the ureter and report 9 new cases and the results of a follow-up study of 18 cases previously reported.

Their follow-up study revealed that, regardless of the type of operation employed, 7 of 10 patients who had lesions graded 1 or 2 lived more than four years after operation and 1 of these lived more than thirteen years. Of the 8 patients who had lesions graded 3 or 4, 6 died within two and one-half years, excluding 1 patient who died after the operation. The remaining patient, who had a growth with a high grade of malignancy, lived more than twelve years, but at the time the paper was written there were indications of probable recurrence of the lesion in the bladder. In the light of these findings, it must be stressed that in cases of low grade ureteral carcinoma—and in the majority of cases the grade of malignancy is low—early diagnosis is of the utmost importance, because there should be a chance for moderately long survival if adequate treatment is undertaken at once.

The tendency of epithelioma of the ureter to recur in the bladder has been pointed out, and this feature was emphasized as the follow-up studies became of longer duration. A tumor of the bladder may follow a ureteral neoplasm with no apparent relation to the method of treating the tumor in the ureter.

The possibility of growth of these tumors by lymphatic extension or by direct extension down the ureter and through its walls to contiguous structures is mentioned, and it is brought out that complete extirpation of the kidney, ureter, all periureteric adipose tissue and the ureterovesical segment of the bladder is the procedure of choice.

In the 9 new cases a diagnosis of primary ureteral neoplasm was proved after examination of the pelvis. In 1 case the kidney was not removed because of extensive bilateral pulmonary tuberculosis, which made the patient an extremely poor surgical risk. In this case the tumor was situated at the right ureterovesical juncture in the intramural portion of the ureter, and transurethral electrocoagulation was considered to be the only feasible therapeutic procedure to be followed under the circumstances. However, retrograde pyelography subsequently revealed the renal pelvis to have a normal outline.

In the 9 new cases, 6 of the patients were men and 3 were women. The average age was 62.2 years; all of the patients were 57 to 71 years of age inclusive.

All of the tumors were graded according to the classification of Broders for vesical tumors: 3 were grade 1, 4 were grade 2 and 2 were grade 4. Of the 9 tumors, 6 were papillary and 3 were infiltrating of which 1 was grade 2 and 2 were grade 4.

Five of the tumors occurred in the right ureter, and 4 occurred in the left. One lesion was situated in the upper third of the ureter, 1 in the middle third and the rest all occupied the lower third, as has been found in more than two thirds of the cases reported in the literature. In 5 cases mild or severe periureteritis was present.

Dilatation of the ureter and hydronephrosis were prominent features in all 9 cases. Destruction of renal substance was as high as 90 per cent in 1 case and 80 per cent in another. In 2 cases a palpable mass was present at the first examination. In 4 cases secondary infection accompanied by pyonephritis was present. Calculi were not observed as an accompanying feature in any case.

Hematuria and pain were the primary symptoms, and a mass in the loin also occurred frequently. Hematuria was present in 8 of the 9 cases. It was the first symptom in 4 cases and the only symptom in 2 cases. Hematuria was gross in 4 cases and microscopic in 4. Pain was present in 6 cases. It was the first symptom in 5 cases and varied from a dull aching in the loin or lower quadrant to typical renal and ureteral colic, associated with chills and fever.

Cystoscopic examination was of real value in the diagnosis of these ureteral neoplasms. In 3 of the 9 cases, the tumor protruded from the ureteral orifice and biopsy was facilitated. In 1 case, a large tumor surrounded the ureteral orifice. This appeared at first to be attached to the left anterior wall of the bladder and left vesicoprostatic juncture, but when the tumor was removed from the region of the ureteral meatus it became apparent that it protruded from the

33. Counseller, V. S.; Cook, E. N., and Seefeld, P. H.: Primary Epithelioma of the Ureter: A Follow-Up Study of Eighteen Cases with the Addition of Nine New Cases, J. Urol. **51**:606-615 (June) 1944.

ureter. In 5 cases, no evidence of tumor was found on cystoscopic examination. In all cases, however, passage of a ureteral catheter met with obstruction at the site of the tumor, and in the majority of instances catheterization of the involved ureter was accompanied by bleeding, which tended to be moderately profuse. Blood spurting from the ureteral orifice was seen even before instrumentation was attempted in 1 case.

Excretory urography was of no aid in actually demonstrating the presence or position of the lesion in any of these 9 cases but was helpful in revealing the degree of renal function present. In the majority of cases, renal function was diminished to such a degree that the amount of dilatation of the urinary tract above the lesion was not shown.

The presence and position of the lesion itself were best seen in retrograde pyeloureterograms. Ureterectasis, incomplete filling, complete obstruction to the medium and a filling defect were all observed in these cases. A more accurate and exact evaluation of the underlying obstruction process was possible than if pyeloureterography had not been done.

With the aid of these diagnostic methods, it was possible to reach a correct preoperative diagnosis in all the cases under discussion.

Stone.—Browne [34] discusses his experiences with ureteral calculi, based on a series of 200 cases. Except for acute retention of urine, there is nothing that will make a patient seek a doctor quicker than ureteral colic. Erythrocytes usually are found in the urine, and there is generally no fever. One is impressed with the gastrointestinal symptoms, chiefly nausea and vomiting, that accompany ureteral colic. As the stone moves lower in the ureter, urinary frequency and burning on urination increase. When infection is present and the ureter is blocked by the stone, there may be high temperature and severe prostration.

Many stones will pass unaided. This occurred in 17 cases. No stone situated in the upper and middle portions of the ureter passed spontaneously. Browne has not had much success with injecting oil or anesthetics above the stone or giving drugs by mouth to aid the passage of calculi.

In 141, or 70 per cent, of the cases the calculi were removed with the cystoscope. The simple passage of a catheter by the stone caused its prompt delivery in the majority of cases. If this did not prove successful, one or more catheters were passed up to the kidney and left there for two or more days. Usually, after this the stone was passed in twenty-four hours or crumbled from the hard catheter lying against it. Irrigation has been advocated to keep the catheter open, but Browne expresses the opinion that this is to be condemned because of the danger of introducing infection into the kidney. If the catheter becomes plugged, the urine will escape around it anyway. Sulfathiazole was given continuously to prevent infection, which causes the most trouble. Some stones impacted in the wall of the bladder have been removed by enlarging the ureteral orifice with a Turner electrode, then passing a metal bougie by the stone, thus engaging and removing it. Browne does not use this instrument any more for fear of tearing the ureteral wall. He has tried the Councill extractor but found that it is too rigid to be passed any distance up the ureter without danger of injury.

In 34 cases the calculi were removed by operation. In 12 of the 34 cases the calculi were in the upper part of the ureter; in 5 cases they were in the middle third, and in 17 cases they were in the lower third of the ureter. He uses a lateral incision, parallel to Poupart's ligament, in removing calculi from the lower part of the ureter, because the ureter can be found easily above the bifurcation of the common iliac artery. From this point the ureter is readily followed until the stone is felt, and if the ureter is very deep in the pelvis, the incision can be extended to and through the sheath of the rectus muscle, thus giving ample exposure. If necessary, the bladder can be opened. In 2 cases, vaginal ureterolithotomy was performed. The stones were low and palpable through the vaginal wall.

Browne is using manipulation less frequently and is operating more frequently in cases of ureteral calculi. If after three trials with the cystoscope the stone fails to pass and shows evidence of impaction, he operates. If there are no symptoms, if there is no infection and if the stone is small, the patient is kept under observation and often in time the stone will pass.

Stricture.—Fergusson [35] reports a case in which perirenal urinary extravasation occurred on the right side as the result of obstruction of the lower part of the ureter by carcinomatous lymph nodes. The patient was a man aged 39 years. The primary carcinoma in the stomach was not discovered until necropsy was performed. Reference was made to a few reported cases of metastatic involvement of the ureter by distant

34. Browne, H. S.: Experiences with Ureteral Calculi, J. Urol. **50**:301-303 (Sept.) 1943.

35. Fergusson, J. D.: Ureteral Stricture with Perinephric Urinary Extravasation, Caused by Metastases from a Silent Carcinoma of the Stomach, Brit. J. Surg. **31**:283-286 (Jan.) 1944.

neoplasms. The author mentions the difficulties which may be encountered when a malignant lesion is not suspected.

BLADDER

Paralysis.—Riches [36] discusses the methods and results of treatment of paralysis of the bladder due to spinal injury. He states that after such paralysis occurs the only satisfactory methods of voiding are voluntary micturition, periodic reflex of a lesion on the cauda equina or suprapubic cystotomy.

The main obstacle to the final attainment of a satisfactory act is infection of the urinary tract; other factors which may retard recovery are urinary leakage, which favors development of pressure sores, and prolonged overdistention, which leads to muscular damage and fibrosis. Infection of the urinary tract may cause death or permanent disability. It is introduced by urethral catheterization. Urethral catheterization should be forbidden absolutely unless and until surgical facilities are perfect. The relief of retention is not an urgent matter and is rarely necessary in the first twenty-four hours. Overflow incontinence is a safe solution of the problem of retention but may produce dermatitis of the urinary tract and pressure sores, especially if the patient is a woman.

If retention must be relieved on account of pain, the alternatives which are safer than a urethral catheter are: suprapubic aspiration, suprapubic catheterization and suprapubic cystotomy. Suprapubic catheterization of the distended bladder offers an efficient method of treatment. It can be combined with tidal drainage after two days.

Manual expression is too hazardous and uncertain to be advised for general use.

To be satisfactory for either immediate or permanent treatment, any suprapubic opening must be made high and must be water tight.

Intermittent catheterization should be reserved for mild retention and limited in any event to two days. If there is no recovery after two days the patient should be treated by suprapubic catheterization, with subsequent tidal drainage. Tidal drainage with an indwelling urethral catheter should be used only in a center and by a person who has had special experience with the method. There should be no delay in replacing it by suprapubic catheterization if gross inspection of the urine shows evidence of infection.

36. Riches, E. W.: The Methods and Results of Treatment in Cases of Paralysis of the Bladder Following Spinal Injury, Brit. J. Surg. **31**:135-146 (Oct.) 1943.

Tumor.—Moore,[37] in discussing carcinoma of the bladder, describes his technic for cystoscopic implantation of radium element. He states that to be suitable for cystoscopic implantation of radium the tumor should be in a situation favorable for a good view and for attack through a direct cystoscope; this would include tumors involving the trigone, the lateral bases, the posterior wall and the posterior half of the lateral walls. If the growth is in the vesical dome, the anterior wall or the anterior half of the lateral walls, this method is unsuitable. He grants that implantation of radium or radon by open operation permits a more accurate placing of the agent and from the surgeon's standpoint is attended by fewer technical difficulties. On the other hand, in certain cases cystoscopic implantation of radium is highly desirable, carries less risk and produces fewer complications, a much shorter period of disability and when properly performed gives equally satisfactory results.

In a review of 96 cases of carcinoma of the bladder, Moore found that 11 patients had been treated by implantation of radium element cystoscopically. Seven were women, and 4 were men. For 8 the neoplasm was graded 2, and for 3 it was graded 3. The ages of the patients at the time of treatment varied from 42 to 87 years and averaged 69 years. Six of these patients are living, and 5 have died. Among those surviving are several who have been treated comparatively recently. Of the 5 patients listed as dead, the period of survival after treatment varied from six months to six years and averaged three and three-tenths years. The average age of the patients at death was 77.4 years.

The necessary instruments and equipment for implanting radium cystoscopically are as follows: (1) a special cystoscopic radium implanter (Moore), (2) platinum needles containing radium element, 1, 3 or 5 mg., (3) a standard Braasch direct cystoscope and (4) a Foley catheter, 24 or 26 F., with a 75 cc. bag. The radium needles should not be over 10 to 17 mm. in length. Each is threaded with stout silk about 25 cm. in length if the patient is a woman. If the patient is a man, a no. BB lead shot is clamped on the silk thread about 2 cm. from the eye of the needle. One needle for every square centimeter of growth should be prepared.

The jaws of the implanting forceps are grooved longitudinally, permitting the needle to be held firmly and without deflection during its insertion. The end of the forceps is blunt, which insures

37. Moore, T. D.: Carcinoma of the Bladder: An Improved Technique for the Cystoscopic Implantation of Radium Element, J. Urol. **51**:496-504 (May) 1944.

against penetration of the wall of the bladder more deeply than the length of the exposed needle. A direct Braasch cystoscope has been used routinely; an indirect instrument is unsuitable for this purpose. A Foley catheter with a 75 cc. bag is included on the tray; the bag is distended with 120 cc of sterile water, the purpose of which is threefold: to hold the radium at the place of implantation, to keep at a distance the remainder of the vesical wall, in order to protect the patient from radiation cystitis and vesical contracture and to block with the distended bag the vesical outlet and prevent the loss of the radium.

Either low spinal or pentothal sodium anesthesia is usually administered. If the tumor is of a sessile type, electrocoagulation of its entire surface is carried out along with a small margin of surrounding healthy tissue. A radium needle is locked in the implanting forceps, with enough of the needle projecting to reach the deeper portion of the tumor. The end of the cystoscope is placed firmly against the site selected, the ocular is removed and the implanter is introduced through the sheath, with the lead shot preceding the needle. When the resistance of the tumor is sensed, the needle is inserted by a short thrust; the implanter then is unlocked and withdrawn. The ocular of the cystoscope is replaced; the needle then may be seen, with the thread and lead shot lying free in the bladder. Another site is selected approximately 1.5 cm. from the former, and this procedure is repeated until the required number of needles have been implanted.

For women identifying lead shot can be used, but it is more convenient to use long threads of silk attached to the radium needle, the thread being brought out of the urethra so that the radium can be removed. The cystoscope can be reinserted alongside these threads, and as many as seven radium needles have been implanted in the female bladder in this way. For men this technic is impractical, and the use of identifying lead shot attached closely to the needle is far more satisfactory. The cystoscope is then removed and the 75 cc. Foley catheter inserted. If the capacity of the bladder is not too limited, 120 cc. of sterile water is used to distend the bag.

The patient is returned to his bed, and the catheter is attached to an irrigator by means of a T tube, with an extension tube into a sterile bottle at the bedside. If there is much oozing of blood, a small amount of acriflavine solution (1:5,000) containing sodium citrate (1 per cent) is left in the bladder, and the drainage tube is clamped for one hour. The sodium citrate prevents clotting of blood. The tube is unclamped every hour, and additional irrigating solution is instilled until the drainage is clear or only pink. In this way, troublesome obstruction of the catheter with clots is avoided.

Depending on the amount of radiation desired, the needles are left in place as long as necessary, usually from forty-eight to seventy-two hours. A direct cystoscope is then reinserted, usually with the patient under pentothal sodium anesthesia; the lead shots are picked up with the cystoscopic forceps and the radium removed. In women, the Foley catheter is removed and the radium is removed by traction on the silk threads.

Herger and Sauer [38] consider the factors which influence success or failure of external radiation in the treatment of carcinoma of the bladder. Such factors are the histologic appearance, the size and the extension of the tumor as well as the general condition of the patient and the radiosensitivity of the neoplasm. In addition, the technic of radiation employed and the amount of radiation energy delivered are of importance in influencing the results which may be accomplished by irradiation therapy.

Results in 160 cases in which carcinoma of the bladder was treated by external radiation from January 1938 through December 1941 are reported. There were 25 cases of papillary carcinoma, 91 of papillary infiltrating carcinoma and 44 of solid infiltrating carcinoma.

Various technics of external radiation were employed in the treatment of these carcinomas. If 200 kilovolts of radiation was given, two, three or four fields were treated with a daily increment varying from 100 to 400 r. If supervoltage radiation was employed, radiation was given through three or four portals with a daily increment of 100 to 300 r.

Satisfactory results were obtained in more than 50 per cent of the cases of papillary and papillary infiltrating carcinoma. In 13 of these cases the tumor disappeared entirely after external radiation alone. In 44 cases great regression in the size and number of the lesions was obtained. This rendered the tumor suitable for subsequent transurethral treatment. In 24 cases, regression was only temporary. No response from external radiation was obtained in 35 cases of papillary carcinoma.

Of the 44 cases of solid infiltrating carcinoma a favorable end result was obtained in only 1 case. In the remaining 43 cases, the response to irradiation was unsatisfactory. It was concluded that no more than palliation may be accomplished by external radiation in cases of solid infiltrating

38. Herger, C. C., and Sauer, H. R.: A Consideration of the Response of Bladder Tumors to External Radiation, J. Urol. **50**:310-321 (Sept.) 1943.

carcinoma. This tumor is radioresistant and is best treated by interstitial radiation or by surgical procedures.

Tremblay, Crane and Harris [39] report a case of malignant osteogenic tumor of the bladder showing histologic, histochemical and chemical features of an osteogenic sarcoma. Eight other cases of primary malignant osteogenic tumor of the bladder have been reported in the literature. This type of tumor is believed to originate from remnants of the wolffian body.

Hirsch and Gasser [40] report a case of extramural rhabdomyosarcoma in the tissues behind the trigone and prostatic urethra of the urinary bladder in a boy aged 5 years. The position of this type of tumor favors the conclusion that it usually occurs primarily in the prostate gland; however, it may occur along the vas deferens.

Khoury and Speer [41] say that 8 cases of rhabdomyosarcoma of the bladder have been reported in the literature. They have added another case. The growth was situated at the trigone. The tumor grew slowly, surrounded the urethra, infiltrated the vesical wall, prostate gland and verumontanum and produced obstruction of the urethra. This resulted in hydronephrosis, ascending infection of the urinary tract and formation of a urachal fistula. The therapeutic procedures were as follows: total cystectomy and abdominal ureterostomy followed by two stage, bilateral ureterosigmoidostomy. Death occurred two and one-half months after the ureterosigmoidostomy, due to ascending infection of the urinary tract.

Stone.—Lepreau and Jenkins [42] report a case of a large vesical calculus. The patient, a man aged 34 years, had had considerable vesical difficulty and had lost 23 pounds (10.4 Kg.). On physical examination a stony, hard, rounded abdominal mass was found. Roentgenologic examination revealed an extremely large area of calcification in the region of the bladder. A suprapubic incision was made. A large friable calculus was removed, with the aid of an obstetric forceps. The patient recovered completely. The calculus weighed 2½ pounds (1,134 Gm.) and was composed of phosphates and carbonates.

A review of the literature reveals that the next largest vesical calculus removed with survival of the patient was reported by Smith. This stone weighed 2 pounds and 6½ ounces (1,084 Gm.). In this report no follow-up data were included. Randall removed a vesical calculus that weighed 4 pounds (1,800 Gm.). The patient died thirty-six hours after the operation. This is the largest vesical calculus that has been removed during life.

Cystitis.—Pool and Rives [43] discuss the treatment of interstitial cystitis with silver nitrate. A urethral catheter is inserted, and the contents of the bladder are evacuated. The bladder then is irrigated with a saturated solution of boric acid. Then 30 to 60 cc. of a 1:5,000 solution of silver nitrate is instilled into the bladder and permitted to remain for three or four minutes if it does not cause intolerable irritation. At the end of this period, the solution is permitted to run out through the catheter, which is then withdrawn. The patient usually experiences some dysuria and vesical irritability for two or three hours. Treatments are repeated daily unless a severe reaction occurs; in this case they are repeated every other day. For subsequent treatments the concentration of silver nitrate in the solution is increased to 1:2,500, 1:1,000, 1:750, 1:500, 1:400, 1:200 and finally 1:100. If, at any time, the reaction is too severe, the concentration is increased more slowly. The results of this treatment were satisfactory in all but 1 of 34 cases.

In a year and a half, 153 cases of interstitial cystitis were observed at the Mayo Clinic. In all of these cases the diagnosis was made by cystoscopic examination. In 68 of the 153 cases, the patients did not remain at the clinic for treatment. In 74 of the remaining 85 cases, silver nitrate was employed. In 11 of the 85 cases, treatment consisted of overdistention of the bladder while the patients were under anesthesia.

In 9 (12 per cent) of the 74 cases the patients were men and in 65 (88 per cent) they were women. The youngest patient was 22 years of age, and the average age was 51.5 years. The average duration of the disease before the patients came to the clinic was six and two-tenths years, which indicates that it has a tendency to become chronic. In 1 case, the disease had been present for twenty years. In 67 of the 74 cases, the patients had had one or more attacks before

39. Tremblay, R. G.; Crane, A. R., and Harris, A.: Primary Osteogenic Sarcoma of Bladder, J. Urol. **51**: 143-148 (Feb.) 1944.

40. Hirsch, E. F., and Gasser, G. W.: Extramural Rhabdomyosarcoma of the Neck of the Urinary Bladder, J. Urol. **51**:517-519 (May) 1944.

41. Khoury, E. N., and Speer, F. D.: Rhabdomyosarcoma of the Urinary Bladder: A Clinico-Pathological Case Report with a Review of the Literature, Including a Tabulation of Rhabdomyosarcoma of Prostate, J. Urol. **51**:505-516 (May) 1944.

42. Lepreau, F. J., Jr., and Jenkins, R. H.: Instrumental Removal of a Two-and-a-Half-Pound Bladder Calculus, with Recovery, New England J. Med. **229**: 937-938 (Dec. 16) 1943.

43. Pool, T. L., and Rives, H. F.: Interstitial Cystitis: Treatment with Silver Nitrate, J. Urol. **51**: 520-525 (May) 1944.

they came to the clinic; this indicates that various types of therapy must have been employed.

Analysis of a specimen of urine obtained by catheterization revealed pyuria in 43 of the 74 cases. The grade of pyuria, on the basis of 1 to 4, was as follows: grade 1 in 37 cases, grade 2 in 4 cases, grade 3 in 1 case and grade 4 in 1 case. A bacterial culture of the urine was positive in only 1 of the 74 cases.

The severity of symptoms, which was graded on a basis of 1 to 4, was as follows: grade 1 in 4 cases, grade 2 in 23 cases, grade 3 in 40 cases and grade 4 in 7 cases. When the patients were first observed at the clinic the capacity of their bladders ranged from 50 to 600 cc. The average capacity was 151.5 cc.

In all of the 74 cases, silver nitrate was employed, according to the technic previously described. The average duration of treatment was fourteen and two-tenths days. In several cases the patients were advised to have their family physician continue this treatment after they returned to their homes. In 66 cases, silver nitrate was the only type of therapy employed. In 8 cases, silver nitrate failed to relieve the symptoms and overdistention of the bladder was employed subsequently.

The immediate results of treatment with silver nitrate were classified as follows: excellent in 52 cases (70 per cent), good in 14 cases (19 per cent) and poor in 8 cases (11 per cent). The results were considered excellent if the patient had been relieved of pain and did not have to micturate oftener than once during the night or oftener than three or four times during the day.

In 31 of the 74 cases, cystoscopy was performed at the completion of treatment with silver nitrate at the clinic. In 5 there was no change in the cystoscopic appearance although the symptoms had been alleviated. In 18 the treatment produced great improvement, which was characterized by diminution of pain, decrease in the number and size of the lesions and increase in the vesical capacity. In 8 there was no cystoscopic evidence of interstitial cystitis after the completion of one course of treatment with silver nitrate.

In 70 of the 74 cases, follow-up data were obtained for from three and five-tenths to twenty-one months after the patients had been dismissed from the clinic. In 29 of the 70 cases, the patients had not had any recurrence of the previous symptoms, but some symptoms had recurred in 41 cases. In many of these cases, the symptoms were not so severe as they had been previously; in other cases, the symptoms were just as severe as they had been previously but they responded to another course of treatment with silver nitrate. Pool and Rives express the opinion that in many cases the disease will respond permanently to the second or even the third course of treatment with silver nitrate. Forty-eight of the patients underwent further treatment either because they had been advised to do so or because of a recurrence of symptoms. The duration of the relief of symptoms varied from one to twenty-one months, and the average was seven and six-tenths months.

Pool and Rives concluded that interstitial cystitis is a poorly understood urologic entity, and its presence often is not recognized. Its manifestations frequently are bizarre, and patients who have the disease often are classified as neurotic. Treatment with silver nitrate has been as satisfactory, or more satisfactory, than any other type of treatment which they have employed. It is economical and convenient and does not require the use of anesthesia. In cases in which the bladder is extremely irritable, it may be necessary to employ overdistention of the bladder before starting treatment with silver nitrate. So far as they have been able to determine, there are no contraindications to this type of treatment. The treatment can be carried out easily by the general practitioner, and it will enable him to cooperate with the urologist in the treatment of this disease.

Fistula.—Willan and Shaw [44] report a case of uterovesical fistula. The fistula apparently occurred after the use of radium in the treatment of metrorrhagia. An opening occurred between the base of the bladder and the cervical canal. In reported cases of vesicovaginal fistula, as in this case, a considerable time elapsed between the use of radium and the establishment of a fistula. Two operations were required before closure of the fistula was effected: first, a combined intravesical and intraperitoneal operation and, second, an intravesical operation. At the time of this report the patient had full control of urination when in bed and she had not wet the bed since the fistula was closed. During the day when sitting she also had full control of micturition, but while she was standing or walking control was as yet incomplete. Treatment of the vesical sphincters with the faradic current has helped and is being continued.

Obstruction of the Vesical Neck.—Hyams and Weinberg [45] report a study of hyperplastic change at the vesical neck in the female, based on a review of the embryology, a study of postmortem material and a clinical investigation of

44. Willan, R. J., and Shaw, A. F. B.: A Case of Utero-Vesical Fistula, Brit. J. Surg. **31**:404-406 (April) 1944.

45. Hyams, J. A., and Weinberg, S. R.: Hyperplastic Change at the Vesical Neck in the Female, J. Urol. **51**:149-161 (Feb.) 1944.

the female urethra. In isolated cases, periurethral tubules and a female prostate may be found, but they are without clinical significance. The most constant pathologic finding in the female urethra is cystic degeneration. Inflammation, if present, tends to become chronic and is difficult to eradicate because of the presence of these cysts in the transitional epithelium of the urethra. Hyperplastic change at the vesical neck in the female is relatively frequent. Its presence is associated with severe urinary disturbance and pain. Diagnosis is based on careful urethrocystoscopic examination.

Nesbit [46] states that congenital valves of the prostatic urethra are best removed by transurethral methods. Existing instruments which have been specially designed for the removal of these lesions cannot be safely employed in the majority of cases, and in many infants they cannot be introduced at all. Perineal urethrotomy allows the safe employment of instruments that are standard equipment of all modern urologists, namely, the McCarthy panendoscope, the high frequency generator and the Bugbee electrode. Nesbit reports a case which emphasizes that perineal urethrotomy does not preclude subsequent operation.

Urinary Retention.—Coller and Eastman [47] studied the motor activity and the thermal sensation of the bladder in 22 unselected cases before and after operation for carcinoma of the rectum.

Preoperative cystometrograms indicated a great variation in vesical capacity and intravesical pressure in cases in which the vesical function was normal. A comparison of preoperative and postoperative cystometrograms disclosed no evidence of injury of nerves governing vesical function. The cause of the temporary urinary retention which developed in 5 cases is not known; certain possible causative factors are mentioned and methods suggested for their further elucidation. After drainage with an indwelling catheter for forty-eight hours, oral administration of 1.5 Gm. of sulfadiazine daily did not prevent development of pyuria and bacteriuria. Abdominoperineal resection of the rectum destroys neither the autonomic nor the somatic nerve supply to the bladder. In view of these facts, it is probable that postoperative urinary retention after this operation, as after some other operations, such as hemorrhoidectomy, is due to local trauma and reflex inhibition.

Lymphatics.—Powell [48] states that a study of the lymphatics of the urinary bladder indicates that a thorough knowledge of this system is of definite clinical importance. This anatomic feature should be studied not only by the urologist but by any surgeon who operates on the lower part of the abdomen or pelvic organs, particularly of the female.

The lymphatic network begins in the submucosa where the tiny ducts run directly to the external surface and there join large collectors containing valves. The valved collectors determine the direction in which the lymph flows. Retrograde and collateral circulation may obviously be more difficult in these beaded (valved) vessels, which often form the main trunks. As a general rule, the lymph system of the anterior wall of the bladder is drained by collectors on each side of the midline which fuse and form one large beaded vessel. These run down along the course of the obliterated hypogastric vessels on each side toward the neck of the bladder near the origin of the ureter. There they turn laterally after receiving trunks from the posterior wall and join primary lymph nodes.

There is relatively little anastomosis of the lymph vessels on one side of the median line of the anterior wall with those on the opposite side.

There is a large network of small (unbeaded) lymph ducts completely surrounding the neck of the bladder, which are intimately connected with those of the posterior wall of this organ as well as with those of the uterine cervix. The collectors of the posterior vesical wall, unlike those of the anterior wall, usually leave the bladder separately to course to the regional lymph nodes. Over the floor, or the posterior wall, of the bladder there is abundant anastomosis of the fine lymphatic network of one side of the median line with that of the opposite side. The posterior abdominal lymph nodes receive the lymphatics from the bladder and other pelvic organs.

Cystometrography.—Weyrauch, Lucia and Howard [49] present statistical and clinical data which cast serious doubt on the value of cystometrography as a diagnostic test. The following sources of error are discussed: (1) the great variability of cystometrograms for the three types of bladders—normal, hypertonic and atonic; (2) the inability to distinguish one group from another on the basis of either the slope of the curve or the critical end points; (3) the

46. Nesbit, R. M.: Congenital Valvular Obstruction of the Prostatic Urethra: Notes on Surgical Procedure, J. Urol. **51**:167-169 (Feb.) 1944.

47. Coller, F. A., and Eastman, P. F.: Urinary Retention Following the Combined Abdomino-Perineal Resection, Surgery **14**:223-228 (Aug.) 1943.

48. Powell, T. O.: Studies in the Lymphatics of the Female Urinary Bladder, Surg., Gynec. & Obst. **78**:605-609 (June) 1944.

49. Weyrauch, H. M.; Lucia, E. L., and Howard, J.: The Failure of the Cystometrogram as a Diagnostic Test, J. Urol. **51**:191-209 (Feb.) 1944.

broad overlapping of the pathologic and the normal curves, and (4) the fact that numerous abnormal conditions produce identical changes in the curve.

Cystoscopic examination is far more reliable than cystometrography for distinguishing a neurogenic lesion from an obstructive lesion of the bladder, although this is the outstanding clinical use for which cystometrography has been advocated. Kymographic recordings of the waves of vesical contraction impart slightly more information than do curves obtained with the mercury manometer, but in most respects this newer method is subject to the same inconsistencies as the older procedure. The worth of and the need for the kymograph in the identification of various types of neurogenic bladder are doubted. Conclusions reached from a statistical evaluation of cystometrography have corroborated a clinical distrust of this biologic test. While discrediting its value as a diagnostic aid, the authors recognize that it has been of aid in studying both the normal and the pathologic urinary bladder.

PROSTATE GLAND

Hypertrophy.—Lazarus [50] discusses methods of treatment employed in certain cases of prostatism in which the patients are poor risks. The procedure advocated consists of suprapubic cystostomy performed through a small midline suprapubic incision, followed, after a prolonged period of drainage, by transurethral resection.

This two stage operation is particularly applicable in the following groups of cases: (1) cases of acute urinary obstruction with azotemia, in which a urethral catheter or cystoscope cannot be introduced; (2) cases of severe azotemia associated with fever due to pyelonephritis; (3) cases of severe urinary retention of long standing without azotemia, in which the patients are poor risks; (4) cases of carcinoma of the prostate with renal insufficiency; (5) cases of prostatism complicated by vesical calculi, diverticulums and vesical tumors, and (6) cases in which there are hemorrhagic tendencies.

The advantages of this two stage procedure are: 1. There is an opportunity to institute immediate and adequate drainage of the bladder and at the same time to promote rehabilitation and stabilization of renal function. 2. A suprapubic tube is less likely to cause infection and sepsis than a urethral catheter, especially when prolonged drainage is indicated, as it is for many patients who are poor risks. 3. It enables one to explore bladders digitally for stones and to ascertain the physical characteristics of the obstructing prostate in cases in which preoperative cystoscopy cannot be performed. 4. It permits one to deal adequately with complicating factors such as vesical calculi, vesical diverticulums and vesical tumors. 5. The small incision in the abdominal and vesical walls minimizes the risk of postoperative infection and herniation, decreases the incidence of urinary leakage around drains, enables patients to be out of bed on the third day after operation and greatly facilitates closure of suprapubic wounds after withdrawal of suprapubic drainage tubes. 6. Prolonged suprapubic drainage causes extensive shrinkage and devascularization of the prostate gland and makes it readily amenable, at the proper time, to electrical resection with reduced risk of immediate and later postoperative hemorrhage and infection. 7. It offers an ideal method for through and through irrigation of the bladder following resection. 8. It greatly reduces the time of hospitalization following the second stage of the operation as compared with prostatic enucleation.

Antonio [51] says that treatment of hypertrophy of the prostate gland is usually complicated by the presence of other degenerative diseases and frequently by coronary heart disease. The rapid reduction of blood pressure in the course of a surgical procedure provides an ideal situation for the already impaired coronary artery to be completely occluded. The maintenance of an approximately uniform blood pressure is, therefore, of utmost importance. Excellent results were obtained in 5 cases of prostatic hypertrophy with complicating coronary heart disease in which transurethral prostatic resection was performed with the patient under low continuous spinal anesthesia. The average fall of blood pressure was only 10 mm. of mercury. The operations were uneventful. Antonio says that the combination of low continuous spinal anesthesia and transurethral prostatic resection is safe and dependable for treatment of prostatic hypertrophy complicated by coronary heart disease.

Carcinoma.—Wilhelmi [52] states that the serum acid phosphatase level is of no value for early diagnosis of prostatic carcinoma and that a normal standardized ratio must be recorded before the test is of definite value to the surgeon. The value of the urinary acid phosphatase appears to

50. Lazarus, J. A.: Suprapubic Cystotomy Preliminary to Transurethral Resection in Selected Cases of Prostatism, J. Urol. **51**:404-410 (April) 1944.

51. Antonio, D., Jr.: The Operative Management of Hypertrophy of the Prostate with Complicating Coronary Heart Disease, J. Urol. **50**:344-354 (Sept.) 1943.

52. Wilhelmi, O. J.: Carcinoma of the Prostate, J. Urol. **50**:341-343 (Sept.) 1943.

be more accurate and more constant than that of the serum acid phosphatase. Orchiectomy is an advisable prophylactic procedure in all cases of early prostatic carcinoma and in cases in which this lesion is suspected.

TESTES

Polyorchism.—Handley and Crawford [53] report a case of polyorchism in a normally developed young man. Both testes and spermatic cords were normal except for a firm smooth mobile mass ¾ inch (1.9 cm.) in length and attached to the upper pole of the right epididymis.

An inguinoscrotal incision, 1 inch (2.5 cm.) long, was made and the cord pulled upward. The tumor was felt within the cord at the upper pole of the epididymis and was easily shelled out of areolar tissue without opening the tunica vaginalis. The tumor measured 2 by 1 cm. Its outer surface was smooth and white, and small venules were stretched across it. A narrow white band divided the cut surface into a smaller upper and a larger lower part, both of which were pale yellow. Microscopic examination showed a miniature testis. There was a well formed tunica albuginea but no tunica vaginalis. A body and an epididymis were present. The seminiferous tubules showed an attempt at spermatogenesis; in some places this had reached the spermatid stage. Other areas showed hypoplasia similar to that seen in incompletely descended testes. Interstitial cells were present in normal proportions. The tubules of the epididymis were normal.

In 1933, Boggon found in the literature reports of only 11 cases of histologically proved polyorchism. He reported another case at that time. It seems that a single vas usually serves the double testis, but there may be a double vas. The extra testis usually is on the left side, and it may show spermatogenesis. In the case reported by Boggon, operation was performed on account of torsion. Histologic examination did not reveal spermatogenesis. In 1896, Lamb collected reports of 23 cases and found that, in addition to the extra testis, there also was an extra excretory apparatus. In none of these cases was the diagnosis proved histologically.

Cryptorchism.—Abrahamson [54] says that the incidence of cryptorchism is high among men examined for military service. Orchiopexy for cryptorchism was first reported by Rosenmerkel. Bevan described a procedure in which the spermatic vessels are divided to allow the testis to enter the scrotum. Ombredanne brought the testis through the scrotal raphe so that both testes were in the same compartment of the scrotal sac. Cabot and Nesbit reviewed the various methods of placing traction on the testis and used elastic traction to lengthen the spermatic cord and retain the testis in the scrotum. Multiple stage procedures for abdominal cryptorchism were described and used successfully by Cabot. Torek suggested fixation of the testis into the thigh. This procedure has been extensively used by several surgeons. Several surgeons have sutured the gubernaculum to the fascia of the thigh.

Abrahamson describes an operative procedure adapted to the surgical problems involved in cryptorchism, with the added physiologic benefit of preserving the function of the testis.

An inguinal incision adequate to expose both the internal inguinal ring and the neck of the scrotum is made. This must be varied according to the position of the testis.

The hernial sac is isolated and liberated from the structures of the spermatic cord. The gubernaculum is isolated and left attached; the sac is liberated and cut across near the testis. The proximal portion is ligated. The distal segment of the sac is incised longitudinally and everted so as to envelop and protect the cord and testis. It is closed loosely with a running suture. The adhesions between the vessels and the cord, especially those about the internal ring and to the peritoneum, are freed. By following the vessels directly upward, retroperitoneally, with blunt and sharp dissection, and separating all adhesions, the vessels are liberated to allow the use of their greatest length.

The scrotal sac is enlarged by manual dilatation, to make a bed for the testis. An incision is made 1½ inches (3.8 cm.) long at the lateral inferior aspect of the scrotum. The gubernaculum testis is then grasped, and the testis is pulled down through the scrotal incision. The distance between the adjacent thigh and testis is measured.

At a corresponding level on the adjacent thigh, and within reach of and close to the scrotal incision, an oblique incision from above downward and mesially, 1½ inches (3.8 cm.) long, is made, and the fascia of the thigh is exposed by retracting the lateral margin of this incision.

A flap, 1 inch (2.5 cm.) wide, is cut from the lateral aspect of the exposed fascia and reflected medially toward the scrotum. It is important to cut and reflect this flap at such an angle that it points toward the testis so that it is not twisted at its base. When the fascial flap has been ad-

53. Handley, R. S., and Crawford, T.: A Case of Polyorchidism, Brit. J. Surg. **31**:300-301 (Jan.) 1944.

54. Abrahamson, R. H.: Operative Technique for Cryptorchidism, J. Urol. **51**:301-314 (March) 1944.

justed in length and direction to the position of the testis and gubernaculum, the posterior lip of the scrotal incision is sutured to the medial lip of the incision in the thigh with interrupted sutures.

If the testis can be brought down to within 1½ inches (3.8 cm.) of the thigh, the fascial flap is reflected back toward the testis and two sutures are placed between the edge of the fascia and the tunica albuginea of the testis. The entire gubernaculum is then placed on the surface of the reflected fascia and attached by two or three carefully placed sutures.

If the testis cannot be brought down within 1½ inches (3.8 cm.) of the thigh without undue tension and if the intervening distance is 1½ to 3 inches (3.8 cm. to 7.6 cm.), the available gubernaculum (only) is placed on the reflected surface of the fascia and sutured to it at whatever point they meet. No sutures are placed between the fascia and the tunica albuginea.

The anterior lip of the scrotal incision is then sutured to the lateral lip of the incision in the thigh, and if right angle incisions were necessary they are closed with interrupted sutures. The scrotum now completely surrounds the anastomosis of the fascia to the gubernaculum and the fascial flap. The wound is dusted with sulfanilamide powder and dressed with petrolatum gauze.

Hernioplasty without transplantation of the cord is now effected by two or three sutures, to bring the conjoined tendon and the internal oblique muscle to the shelving edge of Poupart's ligament. The external oblique muscle is closed with a running suture.

The second stage of this procedure is done two to six months later (whenever the testis lies free in the scrotum). It consists of incising the skin and fascial flap through the skin of the thigh, leaving the skin of the scrotum intact and suturing the wound.

The advantages of these procedures are as follows: The spermatic cord is kept under constant tension, which increases its length and prevents retraction of the testis. No foreign material is used for traction, and the fascia used is always available. In cases in which it is not possible to lengthen the cord sufficiently to bring the testis into the thigh, the fascial flap is measured to bridge this gap. The testis remains in the scrotum, its normal position, and is allowed to develop immediately on completion of the first stage (its sensitivity to changes in temperature when it is out of the scrotum is known). The second stage is a simple procedure and does not endanger the testis. If hormonal therapy is indicated, it can be instituted immediately after the first stage, with the testis in its normal habitat.

Reasons for operative intervention for cryptorchism are as follows: 1. To introduce the testis into the scrotum. After puberty, this is the only site in which the testis will produce both internal and external secretions, normal in amount and character. Consequent atrophy, sterility and lack of development of secondary sex characteristics are prevented. 2. To prevent traumatic derangements of the testis. 3. To prevent the growth of malignant lesions of the testis, which occur more frequently when it is in an abnormal position. 4. To effect cosmetic improvement.

Tumor.—Kleiman [55] says that tumors of the testis are relatively uncommon and more than 95 per cent of such tumors are malignant. He reports a case in which a man, aged 51 years, complained of enlargement of the scrotal contents. The contents of the left side of the scrotum were three times their normal size. Roentgen therapy caused the scrotal mass to shrink to less than half of its former size. Three weeks later, orchiectomy was performed. A pathologic diagnosis of hemangioma cavernosum was made.

Gilbert [56] reports a case of carcinoma of an atrophic right testis. The atrophy was caused by orchitis due to bilateral mumps which had occurred sixteen years previously. The patient had been sterile since that time. A review of approximately 5,500 cases of tumor of the testis reported in the literature reveals that orchitis due to mumps has occurred in 24 cases. In 3 of the cases bilateral tumors developed after the orchitis. Brief reference is made to Schoenfeld and Beebe's study concerning the size of testes at various ages and of the use of models for clinical comparison.

The average age of the patients in the 24 cases was 35 years and the average interval between the orchitis and the development of the tumor was approximately twelve years. There was a history of trauma in 4 cases. The following types of tumor were encountered: unicellular (seminoma) in 13 cases; teratoid in 9 cases, and miscellaneous in 2 cases. One patient with a unicellular tumor lived seven years after operation, but only 1 with teratoma survived five years.

It appears from this collective survey that there is no direct relationship between orchitis

55. Kleiman, A. H.: Hemangioma of the Testis, J. Urol. **51**:548-550 (May) 1944.

56. Gilbert, J. B.: Tumors of Testis Following Mumps Orchitis, J. Urol. **51**:296-300 (March) 1944.

due to mumps and the development of tumor of the testis.

EPIDIDYMIS

Fibromyoma.—Gordon-Taylor [57] reports a case of fibromyoma of the epididymis of an undescended testis on the right side in a man aged 42 years. The organ was of normal size; at its lower end was a firm ovoid tumor, which was painless and which was said to have been present for six months. The tumor was removed, and pathologic examination revealed that it was a fibromyoma.

Leiomyoma constitutes the most frequent variety of the rare group of benign growths of the epididymis; 13 cases were collected by Friedman and Grayzel (1941); in 2 of these cases bilateral tumors were present. The case reported by Gordon-Taylor is unique, as the tumor was situated in the epididymis of an undescended testis.

There usually is a history of gradual, painless increase of an intrascrotal swelling, although intermittent pain occasionally may have been noted. In some of the cases there has been an antecedent of gonorrheal epididymitis.

The tumor is most frequently situated in the globus major or minor; it is rarely found in the corpus of the epididymis. The growth is round or ovoid, firm to stony hard, nodular and not usually tender. An associated hydrocele is said to be present in 50 per cent of the cases.

Correct diagnosis has only rarely been made preoperatively; the tumor often is regarded as a testicular neoplasm, and orchiectomy is performed. At the time of operation, the size of the tumor has varied from that of a pea to that of a mandarin orange.

SCROTUM

Tumor.—Nation and Potampa [58] report a case of neurofibrosarcoma of the scrotum. The patient was a man aged 71 years with a scrotal mass which caused him more inconvenience than pain. The mass was 15 by 20 cm.; it was firm and irregular but not tender. The testes lay free on the anterior aspect, and the right spermatic cord fused into the proximal part of the tumor. The entire tumor was removed, and microscopic examination revealed that it was a fibrosarcoma or a neurofibrosarcoma. Convalescence was uneventful.

Nation and Potampa express the opinion that this growth did not arise from the cord but probably originated from tissues of the scrotum or from the periosteum. In the differential diagnosis of a scrotal tumor one first should determine whether the tumor is of testicular or extratesticular origin, since one of the former origin is liable to be much more malignant than one of the latter. Sarcoma is one of the most common of the extratesticular tumors; 30 to 60 per cent of these tumors are of this type. They are more common in the testicular tunics than in the spermatic cord. Scrotal tumors of extratesticular origin, such as the one reported by these authors, must be dealt with as tumors of the same type would be if encountered elsewhere in the body.

PENIS

Tumor.—Wattenberg [59] reports a case of primary fibrosarcoma of the glans penis. No evidence of metastasis was apparent. This is the eighth case of primary fibrosarcoma of the penis to be reported and the third case in which the tumor originated in the glans penis. Amputation through the middle portion of the penis was performed.

URETHRA

Diverticulum.—Menville and Mitchell [60] report 11 cases of diverticulum of the female urethra. At Charity Hospital of Louisiana, in New Orleans, this lesion was found predominantly in the Negro race. The lesion is acquired in the vast majority of cases and almost invariably becomes infected. The pathognomonic sign is a fluctuating mass which empties on pressure. The treatment of choice is excision of the sac.

Caruncle.—Walther,[61] in a review of 100 cases of urethral caruncle in females, found 5 instances of unsuspected carcinoma and 2 instances of precancerous lesions in the 47 cases in which pathologic examination was carried out. A comparative consideration of the clinical aspects of urethral caruncle and urethral carcinoma makes clear that little reliance can be placed on pure clinical diagnosis, because of the similarities

57. Gordon-Taylor, G.: A Case of Fibromyoma of the Epididymis in an Undescended Testicle, Brit. J. Surg. **31**:146-147 (Oct.) 1943.

58. Nation, E. F., and Potampa, P. B.: Unusual Scrotal Tumor: Report of a Case of Neurofibrosarcoma, J. Urol. **51**:174-177 (Feb.) 1944.

59. Wattenberg, C. A.: Primary Fibrosarcoma of the Penis: Review of the Literature and Report of a Case, J. Urol. **51**:543-547 (May) 1944.

60. Menville, J. G., and Mitchell, J. D., Jr.: Diverticulum of the Female Urethra, J. Urol. **51**:411-423 (April) 1944.

61. Walther, H. W. E.: Caruncle of the Urethra in the Female with Special Reference to the Importance of Histological Examination in the Differential Diagnosis, J. Urol. **50**:380-388 (Sept.) 1943.

between these conditions. Since histologic examination is imperative in every instance of presumable urethral caruncle in order to exclude carcinoma, it is important that a method of treatment be employed which permits the securing of a specimen suitable for microscopic study. The author describes a method of electrosurgical excision which meets this criterion and which also is simple. It can be performed quickly and removes the growth completely. It results in a minimal amount of scar tissue.

MÜLLERIAN DUCT

Cyst.—Deming and Berneike [62] say that cysts of the deep part of the male pelvis fall into five general groups: (1) the cysts arising from the wolffian body or its ducts, (2) those arising from the müllerian ducts, (3) those which result from an obstruction of the ejaculatory ducts by enlargement of the prostatic utricle, (4) those of the seminal vesicle proper, which are thought to be due to occlusion of a diverticulum, and (5) those of inflammatory or parasitic origin.

Coppridge reports 6 cases in which massive midline cysts simulated a distended bladder and originated deep in the tissues between the bladder and the rectum. In many of these cases the cyst probably originated in the müllerian ducts. In addition, he reports a case in which a cyst undoubtedly arose from a remnant of a müllerian duct.

In the available reports of cases of cysts of the müllerian ducts, several common features are prominent. Most of the patients were between the ages of 19 and 40 years. All of the tumors were symmetric and situated in the midline. Most of them were fairly large and were palpable abdominally. None contained spermatozoa, and the descriptions of the cystic fluid suggested that in all cases it consisted of various stages of degeneration of blood. When operative removal was attempted, it was found that in all but 1 case the anterior wall of the cyst and the posterior wall of the bladder were practically one and the same structure, which made complete removal extremely difficult and in many cases impossible.

The clinical features characteristic of cysts of the müllerian ducts are: (1) A symmetric cystic mass is palpable rectally just above the prostate in the midline; (2) the prostate gland is normal or at least not directly involved in the cystic process; (3) urethrocystoscopy shows only encroachment on the vesical lumen by an extrinsic mass and perhaps symmetric lateral displacement of both ureters; the utricle may or may not be slightly enlarged, and bloody discharge may be encountered at its orifice; (4) fluid from the cyst does not contain any spermatozoa or parasites and probably consists of only old changed blood; (5) the cutaneous reaction to echinococcus antigen is negative.

Histologically and pathologically there are other features which are characteristic of all cysts of the müllerian ducts. First, the epithelium is cuboidal or low columnar. Second, there is evidence of cystadenoma. Third, a cord of tumor tissue passes from the cyst through the prostate gland to the region of the verumontanum without affecting the adjacent prostatic tissue. Cysts of the müllerian ducts have been treated conservatively by aspiration or radically by excision. Recent literature favors complete removal of the cyst. The most successful approach has been the suprapubic one, since most of the cysts extend well up along the posterior wall of the bladder. Infrequently, the combined abdominoperineal approach may be indicated.

Deming and Berneike report a case in which a man aged 30 had bloody urethral discharge and urinary frequency. He also had a watery discharge from the rectum.

Rectal examination revealed that the prostate gland was normal in size, shape and consistency but that the lateral lobes were somewhat separated near the upper edge. From between the lobes there extended upward a tense, cystic mass, which was roughly in the midline but perhaps slightly larger on the right than on the left side. The upper limits of the cyst could not be reached, nor could it be palpated suprapubically, even on bimanual examination.

The cyst was tapped with a lumbar puncture needle, introduced through the perineum, and about 6 cc. of watery, chocolate-colored, odorless fluid was withdrawn. Eight cubic centimeters of a 40 per cent solution of skiodan was injected into the cyst. Roentgenograms and retrograde pyelograms revealed a pear-shaped retrovesical mass extending up to the dome of the bladder. It was situated roughly in the midline, although it extended farther to the right.

Cystoscopy revealed an appreciable elevation of the trigone and the base of the bladder, but the posterior urethra and the verumontanum showed only moderate vascular engorgement.

Through a midline suprapubic incision the posterior wall of the bladder was exposed by stripping away the peritoneum. Adherent to the

62. Deming, C. L., and Berneike, R. R.: Müllerian Duct Cysts, J. Urol. **51**:563-568 (June) 1944.

lower two thirds of the posterior wall of the bladder was a grayish blue cystic mass about the aggregate size of three hen's eggs. This was dissected away from the bladder with considerable difficulty, and its attachment was traced down to the prostate gland. Attached like two ears to the posterolateral aspects of the cyst were the two seminal vesicles; at the same points, apparently extending into the cyst, were the two vasa deferentia. The stalk of the cyst was traced down to the prostatic urethra, where its attachment was divided. The cyst was removed in toto with most of the prostate gland, both seminal vesicles and the distal 3 inches (7.6 cm.) of the vasa deferentia.

The pathologic report was as follows:

> The portion of the specimen representing the prostate is traversed by a canal 7 mm. in diameter. . . . Sections of the prostate show the usual epithelial lining with ducts and acini. Sections of the large cyst wall itself show the wall to be made up of a thick layer of smooth muscle and fibrous connective tissue. It is partially lined by a flattened layer of deep blue staining epithelial cells. Diagnosis: Müllerian duct cyst, seminal vesicles, and portions of prostate and vasa deferentia.

PATENT URACHUS

According to Atcheson,[63] patent urachus may easily be confused with intra-abdominal conditions, such as acute appendicitis and cystic tumors, if a history of drainage from the umbilicus is not obtained.

In some cases, a patent urachus will change from the fistulous type to the sinus type. In the 2 cases reported by Atcheson, it was of the fistulous type, as evidenced by a history of urinary drainage in early life, but as inflammatory changes occurred the fistula sealed off and a sinus resulted.

It is almost a technical impossibility to excise the tract without opening the peritoneum, especially in those cases in which inflammation has existed. It is suggested that the peritoneum be routinely opened at a point below the umbilicus and that the attached tract and umbilicus be excised in toto.

Treatment of the infection in the tract before surgical treatment is carried out is important. Drainage and irrigation of the tract with some solution such as chloroazodin are satisfactory for the treatment of the infection.

Inflammation may have changed the structures of the urachal area to such an extent that the sections will not always reveal the lumen and epithelial lining of the tract.

63. Atcheson, D. W.: Patent Urachus with a Report of Two Additional Cases, J. Urol. **51**:424-430 (April) 1944.

UROLITHIASIS

Ezickson[64] discusses the relationship of infections of the urinary tract to urolithiasis, on the basis of a series of 134 cases in which there was a history of urolithiasis. The cases were divided into two groups: Group 1 consisted of 64 cases (48 per cent) in which cultures of urine were positive, and group 2 consisted of 70 cases (52 per cent) in which cultures of urine were negative. Urolithiasis is predominantly a disease of the white race, occurring in only 4 Negroes in this series of cases. There was a slight preponderance of males, 57 per cent of the total. The highest age incidence was between 41 and 50 years, comprising 38 per cent of group 1 and 30 per cent of group 2. The majority of all cases (65 per cent in group 1 and 56 per cent in group 2) fell in the age group 31 to 50 years.

There was a definite correlation between urologic operations and infections of the urinary tract. Thus, in 41 cases (64 per cent) of group 1, 66 operations on the urinary tract were performed, while in 16 (23 per cent) of group 2, 20 operations on the urinary tract were done. It can be deduced from the high incidence of operations in group 1 that of the two groups the more definite underlying pathologic lesions requiring surgical intervention were encountered in the cases in which cultures of urine were positive. Whether the infection was the cause or the effect of the urolithiasis could not be determined.

There were 3 deaths in group 1 and 1 in group 2. Of the 3 deaths in group 1, 2 were due to urologic disease and 1 to cardiovascular disease. The 1 death in group 2 was attributable to the cardiovascular system.

Stones were found during the study in 69 per cent of cases in group 1 and 34 per cent of cases in group 2.

An analysis of the cultures showed that Escherichia coli, Staphylococcus albus and Proteus vulgaris were the organisms most commonly found. In repeated cultures, these three organisms consistently predominated.

CHEMOTHERAPY

Campbell[65] discusses the surgical aspects of sulfapyridine anuria and stresses certain points in the treatment of this type of anuria.

The degree of ureteral impaction must be kept in mind throughout the treatment of renal complications caused by the sulfonamide drugs. The

64. Ezickson, W. J.: The Relationship of Urinary Tract Infections to Urolithiasis, J. Urol. **51**:431-436 (April) 1944.

65. Campbell, J. M.: The Surgical Aspects of Sulphapyridine Anuria, Brit. J. Surg. **31**:286-288 (Jan.) 1944.

nature of the crystalline impaction and the consequent difficulties in catheterization vary directly with the interval that elapses from the time the gross hematuria began.

Patients who have sulfapyridine anuria should be catheterized early if they do not respond after a few hours of routine conservative measures. Also oliguria, hematuria and renal colic should be dealt with in a similar fashion if they do not respond within a short period to intravenous administration of fluids and diuretics.

The obstruction may become such that ureteral catheterization is impossible, and a renal operation may be necessary. Patients who cannot be relieved by cystoscopic methods should be treated by pyelostomy or nephrostomy. Operation on one side is adequate if the pelvic contents are fluid. In this case the likelihood is that the ureters can be catheterized in a few days after relief of the anuria, owing to the ability of the lower portions of the ureters to disengage themselves of a large amount of the crystals in a few days.

Bilateral pyelostomy or nephrostomy and decapsulation would be chosen only in cases of delayed anuria in which no secretion follows emptying of the renal pelvis.

Kirwin, Lowsley and Menning [66] state that pyridium (phenylazo-α-α-diaminopyridine monohydrochloride) has proved to be a valuable addition to the physician's weapons against infection of the urinary tract. In a significant number of cases it has been effective in reducing the amount of organized urinary sediment and especially in relieving the characteristic symptoms of urogenital infections, such as dysuria, burning, frequency and nocturia. Relief of symptoms has occurred in most instances, even when no decrease in the amount of organized urinary sediment was observed. This compound may be administered in therapeutic doses, with complete safety throughout the course of common urogenital infections.

GONORRHEA

Harrison, Botsford and Ross [67] describe their experiences with combined therapy with fever and sulfonamide drugs for resistant gonorrhea over a period of ten months. Up to the time this report was written, this has proved to be the most effective available method of treating gonococcic infection resistant to sulfonamide compounds. A description is given of selection of patients, technic of administration of fever therapy, management after treatment and tests for cure. The results have been excellent, and 84 per cent cures (representing 252 patients), as determined by the criteria employed, were obtained among the first 300 patients treated. Four hundred and twenty-six fever treatments were given to this group of patients, and 1 death occurred as a result of combined hepatic and renal failure. No other serious complications were encountered, although there were 10 instances of transitory hepatitis, which subsided completely within two weeks after treatment. Only 10 patients who received one or more courses of treatment were not improved.

Culp, Magid and Kaplan [68] state that resin of podophyllum is unusually successful in producing prompt and complete disappearance of condylomata acuminata, regardless of the size, number, site or duration of the lesions. It is generally agreed that circumcision alone will not prevent occurrence or recurrence of penile lesions. This was supported by the findings in 4 cases. Resin of podophyllum may be applied locally to the lesions as a 25 per cent suspension in liquid petrolatum or as a paste composed of the powdered drug and water. Anesthesia is not required. Treatment is simple; convalescence usually is painless, and the lesions disappear within two to three days after a single application, leaving no ulceration or scarring. Repeated applications of the drug may be necessary in a few instances. Only rarely will there be any time lost from full military duty or similar physical activity.

The surrounding normal tissue usually is unaffected by the drug, but in isolated cases of extensive application under tight prepuces, some balanitis may result. Occasionally circumcision will be advisable because of chemical balanitis and secondary edema of the prepuce, but disappearance of the condylomas simplifies the surgical procedure.

The dramatic results obtained in a series of 100 cases and the simplicity of the treatment with resin of podophyllum prompted the authors to recommend more widespread use of this type of therapy.

HYPERTENSION

Hayes and Ashley [69] have performed cystoscopy on 55 patients with advanced hypertension. The patients had no particular urologic

66. Kirwin, T. J.; Lowsley, O. S., and Menning, J.: The Effects of Pyridium in Certain Urogenital Infections, Am. J. Surg. **62**:330-335 (Dec.) 1943.

67. Harrison, J. H.; Botsford, T. W., and Ross, F. P.: The Treatment of Resistant Gonorrhea with Induced Hyperthermia Supplemented by Sulfonamide Therapy, J. Urol. **51**:215-227 (Feb.) 1944.

68. Culp, O. S.; Magid, M. A., and Kaplan, I. W.: Podophyllin Treatment of Condylomata Acuminata, J. Urol. **51**:655-659 (June) 1944.

69. Hayes, B. A., and Ashley, J. D.: Urological Factors Influencing Hypertension, J. Urol. **50**:366-373 (Sept.) 1943.

symptoms and were under treatment by internists for essential hypertension. There were 22 men and 33 women in the group. Careful histories showed a high incidence of bed wetting and of chills and fever during childhood. Twenty-six of the 33 women had had a toxemia of pregnancy or a pelvic operation or both. On examination 54.5 per cent of the whole group were found to have obstructive lesions of the lower part of the urinary tract. Approximately 60 per cent had various changes in the upper part of the urinary tract, which were commonly ascribed to back pressure. Other lesions found were renal calculi, ureteral calculi, renal cyst, polycystic disease, duplication of ureters and renal pelves and ptosis of one or both kidneys. The lesions found were sufficient in number and importance to suggest a urologic examination in all cases of hypertension, not only for the purpose of improving the condition of the urinary tract but for the purpose of eliminating the cause of the hypertension.

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